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WHERE DO WE GO FROM HERE?

David E. Lilienthal

On October 13, David E. Lilienthal, Chairman of the Atomic Energy Commission, received one of the Freedom Awards given annually by Freedom House in New York. On the occasion of the presentation of the award, Mr. Lilienthal gave the following address.

ONE morning last June at the University of Wisconsin, I was supposed to be on hand to receive an honorary degree. But I wasn't there; I was in Washington before a congressional investigating committee. The President of the University explained my absence by saying that Mr. Lilienthal wasn't there for his degree because he was still answering examination questions. The examination questions in Washington at about that time concerned the garbage cans in the town of Oak Ridge.

Questions about garbage cans may seem something less than vital. But the questioning process is vital.

Now that we know of the Russian achievement there are many important and relevant questions that thoughtful people have to ask about this country's atomic policies and programs: Is the atomic course the country has been pursuing the best way to protect and defend the United States, the best way open to us to contribute to world peace? Is the atom bomb a solution of our military problems; or of the problems of preventing the spread of Communism; or preventing such setbacks for democracy as have already taken place in China and in Czechoslovakia?

Atom or no atom, secrecy or no secrecy, the American people—unless I completely misread their history and their present frame of mind—intend to ask many such questions, and out of public discussion to arrive at some answers. For it has been this rough-and-ready threshing out of problems in the open air of discussion that in the past has been the saving grace of this people.

The question people are asking most frequently today is: "Now what? Where do we go from here?"

Yesterday, so to speak, only the United States, Great Britain, and Canada had accomplished the considerable industrial and technical feat of producing fissionable materials and releasing the energy of the atom. Today the event in Russia that has long been anticipated is no longer expectation but fact. The Russian progress is, of course, a substantial achievement. Dr. Robert Bacher said the other day[1] that "this means that the Russians have moved a long way in the development of atomic energy." Bacher knows what he is talking about.

Before we consider the question of "Where do we go from here?" it is helpful to take a look at where we have been.

In the Baruch plan this country offered a program to remove the threat of atomic warfare, under international control and direction, with enforceable safeguards. Through these proposals we have sought a practical way to rid the world of those morbid suspicions and fears that the very existence of these fantastic weapons foster. We are seeking the safety of all people, not of ourselves alone.

Those proposals have failed of adoption because Russia would have none of them. The proposals the Russians have thus far advanced were ones that in their essentials, we ourselves had studied and considered. And it seemed clear to us that they provided no peace of mind and no safety for anyone, the Russians included. Because these proposals put a premium on clandestine bomb-making they would add to and not diminish suspicion and distrust between nations, and thereby promote war, not peace.

In the absence of agreement on international control, we have followed the only course, in atomic energy, that seemed open to us—that is, the development of the largest, and the most intensive scientific and industrial undertaking in all history, the atomic energy enterprise of the United States. This effort has produced notable advance in fundamental knowledge and aided in developing some of the many beneficial and humane applications of these majestic discoveries. Our efforts have also had this result: Tonight this nation has at hand a considerable stockpile of atomic weapons, improved in technical design and engineering, with other designs well along, and a substantial rate of production.

This, then, has been our atomic course. But it is not the course we prefer. It is not a course that provides the ultimate answer. This we fully realize.

NOW has come this new and important fact about Russian progress. What do we do now?

There is no simple answer, of course, nor will everyone agree even on parts of the answer.

In part, the news means, to me, that we should stop this senseless business of choking ourselves by some of the extremes of secrecy to which we have been driven, extremes of secrecy that impede our own technical progress and our own defense.

It means, to me, in part, that we should lose no time working out a broader area of cooperation in atomic matters with Britain and Canada, on the basis of the most rational and effective use of the combined brain-power and materials of the three nations.

The news means, in part (and I recognize that many will not share this view), that not only should we maintain great strength in weapon development but also we should intensify our efforts in developing the peaceful and benign applications of our new knowledge.

Most important, the news from Russia means that we should seek to de-

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[1] Address to Town Hall, Los Angeles, October 5, 1949.

MILITARY AND CIVIL CONFUSION ABOUT CIVIL DEFENSE

Horatio Bond

Interest in civil defense has increased with the news of the Soviet possession of the atomic bomb. In the following article, Horatio Bond, Chief Engineer of the National Fire Protection Association, reviews the national plans for civil defense made in the Hopley Report published in November, 1948. A brief outline of this report appeared in the April, 1949, BULLETIN.

SINCE the wartime U. S. Office of Civilian Defense was abolished in the closing days of the war, the subject has been tossed about from one official lap to another. First a board of twelve general officers of the Army issued a report. Then the Office of Civil Defense Planning was set up in the Department of Defense which issued a report *Civil Defense for National Security* (the Hopley Report) in November, 1948. In March, 1949, by letter, the President assigned further work on civil defense to the National Security Resources Board.

It is appropriate to comment on the controversial Hopley Report which is a comprehensive statement and a published document, with the hope of more exactly defining the problem and to give some basis for appraisal of further civil defense plans which may be offered by NSRB or other agencies.

The U. S. plans for civil defense suggested in *Civil Defense for National Security* were prepared under the direction of Russell J. Hopley, Omaha telephone executive, for the Secretary of Defense. This report is useful in explaining what is included in civil defense operations and it establishes the sound principle that civil defense should be handled principally by the states. The plans it describes would, however, tend to perpetuate many of the man-power-wasting activities of the old OCD.

Most of the criticism of the Hopley Report has been unjust. The most valid criticism does not seem to have been made. This is that an entirely different kind of statement should have been forthcoming from those on whom we place responsibility for the military defense of the United States.

In the Hopley Report, the military establishment has not done the one part of the job of civil defense which is theirs and theirs only; to estimate the military situation which makes civil defense machinery necessary. It does not say what bombs will fall, or where, or when; or what other weapons may be used against us. Possibly for misguided security reasons the Office of Civil Defense Planning never had such information. While civil authorities should make the plans for defense of their communities, military authorities must at least attempt to define the role of civil defense in terms of the over-all national problem.

DESTRUCTION OF CITIES

THE destruction in at least fifty-four principal German cities and sixty-five Japanese cities, accomplished with incendiaries and high explosives, was a fact before the atom bomb was dropped. It doesn't need atom bombs on our cities to establish the importance of civil defense as at least the equal of army, navy or air force in a nation's defense set-up.

There are many and sometimes weird notions held as to what civil defense is. To many Americans, the term is somehow associated with citizens with a white hat and whistle. As American cities were not bombed, it is difficult for Americans who were not overseas, and under bombing, to have any real idea as to what civil defense is all about.

My own ideas of what civil defense includes may be quite different from those of others, so I had better begin by explaining the background I have for an opinion on the subject.

The National Fire Protection Association is a voluntary society which serves as a national and international clearing house for technical information on fire matters. It is not a trade association for insurance or industry, is not subsidized. It is principally supported by dues and income from the sale of publications.

My association with municipal and other fire protection problems as a member of the staff of the National Fire Protection Association convinced me that World War II would be a fire war, as indeed it was, even to the fire effects of the atomic bomb. A German fire department officer in 1932 wrote a book on how to use incendiaries to destroy cities. Hitler put all his fire departments under the national government in 1936. Fortunately for Germany's enemies, the German air forces paid no attention to the fire chief and his ideas if, in fact, they ever heard of them. The British and U. S. air forces came to a major use of incendiary weapons only after they had discovered their effectiveness by fortunate chance in the choice of early target areas.

As World War II threatened, I felt it was physically possible for a German air force to do great damage and that only England stood between Hitler's airmen and our Atlantic seaboard cities. Consequently, I was early pulling doorbells in Washington to find out who, if anyone, was thinking about this eventuality. Later I was asked to help with fire defense plans of the Office of Civilian Defense, and, in 1943,

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went to London for a tour of duty as adviser to Marc Peter, Jr., the Civilian Defense Attaché at the U. S. Embassy. By that time, the Battle of Britain had been won and the job was not defense but to get British and U. S. air forces to make more effective use of fire destruction as a force to wear down the enemy. The buzz-bombs and rockets had not come along then, and the task was one of "selling" the British and U. S. air force operational authorities on the idea of fire attacks. In 1945, I was again in England, and after V-E Day in Germany, to direct the collection and analysis of fire destruction data for the Physical Damage Division of the U. S. Strategic Bombing Survey. I had originally suggested that the scope of the Survey be enlarged to include a Civil Defense Division, but I had no official connection with the Civil Defense Division of USSBS. That division did a creditable job of reporting on German and later Japanese civil defense. Incidentally the data obtained from USSBS reports, including those of the Physical Damage Division, were meagerly used as a basis for conclusions of the Hopley Report.

The above background is recited to indicate that my approach to the subject of civil defense should be both understanding and sympathetic.

CIVIL DEFENSE IS NOT MILITARY

I FIND it easier to say what civil defense *is not* than to say exactly what it *is*. It is not the promotion of community singing or folk-dancing. It is not a campaign for Victory gardens or for the sale of war bonds. It is not an organization for general welfare activities in cities and towns.

It is not for military activities. A better idea of what is and what is not included in civil defense may be obtained by eliminating all activities which are customarily provided by military agencies: army, navy, marines, coast guard, and air force. But it should be noted that all of these military agencies must practice the functions of civil defense wherever they are quartered in posts, camps, and stations. Also, it may be that civil defense should include measures to be taken by civilians to deal with paratroop invasion in the absence of military units.

Civil defense may be defined as generally covering activities for which the military forces must assume no primary responsibility. Insofar as military personnel is engaged in civil defense, they cannot get on with their primary job of fighting the war to a successful conclusion. Civil defense is "self-help." Civil authorities, who hopefully expect military forces to take over a devastated city and police and rehabilitate it under martial law or otherwise, ignore this fundamental. It is this fundamental which is least understood by both civilians and the military. Both lack knowledge of the multitudinous problems involved. Thus far we have seen no statement of U. S. military authorities which explains to civil authorities that the latter must be prepared for civil defense in their communities as, in event of war, the military will be engaged elsewhere when the bombs begin to fall. The essential fact was explained in the debates in Parliament on the British Civil Defense Bill, that the military may assist in civil defense, but only to the extent of the forces available. Can we do less than expect our own authorities to be similarly straightforward?

The basic purpose of civil defense is to reduce the effects of warfare on civilian life and the civilian economy in order to increase the chances of victory. It is a limited and largely false concept that civil defense is a kind of "umbrella" under which civilians are protected against a "rain" of weapons. Such a concept would justify costly efforts which would not lead to the principal objective, which is victory in warfare against an enemy.

ONLY IN PART DISASTER RELIEF

THE fundamental separation of military and civil action must be kept in mind in appraising civil defense plans. It has been suggested that a good start in civil defense could be made by developing sound plans for dealing with peacetime disasters. Of course, disaster plans are similar in many respects to civil defense plans, but in handling floods, fires, earthquakes, windstorms, and other disasters, local authorities can often fall back on resources of the army and other federal agencies. In wartime, these agencies will have other important things to do. So disaster plans, based on a large measure of outside military or other federal assistance is, in my opinion, not a sound basis for civil defense planning. My choice would be to set up good organization at the state level for civil defense and gain experience for it through application of the organization to peacetime emergencies. Such experience would not preclude military or other federal assistance, but such assistance would be channelled through the type of organization which is arranged to go on its own in the worst emergencies of war.

THE HOPLEY REPORT

THE Hopley Report has cleared away some of the underbrush obscuring the subject. It made clear that it would have nothing to do with folk-dancing, singing, and other community activities which were included in the activities of the wartime Office of Civilian Defense and which tended to obscure the life-and-death seriousness of civil defense.

The Hopley Report should be commended for making the recommendation that civil defense should be principally the function of the states. This carries out the fundamental principle of putting civil defense on a "self-help" basis to take the load off the military agencies. When England faced World War II, the country was divided into nine defense regions. The idea was that in event of invasion each of these subdivisions would be a unit, capable of acting without support from the national government. In the United States, the states are already established as subdivisions of the nation. While it could be argued that other division would be more logical, the fact is that we have forty-eight regional governments, fully established and organized and capable of going on their own without special legislation. These are our great element of strength in defense operations, and the Hopley Report's recognition of the fact is sound and courageous.

MANPOWER

A FUNDAMENTAL principle of war is not to waste manpower. In the United States we have had such enormous resources that we could get through the last major war in spite of a lot of lost motion. The Hopley Report missed an opportunity in that it did not develop this point. The principal criticism directed to the report by fire chiefs is that it did not suggest how they could avoid, in another war, the manpower problems that faced public fire departments in the last two world wars.

The Hopley Report suggests various civil defense activities. If all of

these are to be logically carried out by every city, town, and hamlet, great numbers of people will be unnecessarily tied up in civil defense activities. There is no indication in the Hopley Report of how far organization on such a scale can go without taking people away from other activities important to the conclusion of the war. The kind of statement needed from the President of the United States and his advisors is one which suggests the extent of civil defense organization feasible now, and how such organization should be expanded in emergency. The Hopley Report does not give adequate guidance on this point. This is one of its serious weaknesses which the President and his advisors promptly recognized.

A lot of the trouble with civilian defense in World War II in the United States came about because, with the fetish for a civilian defense organization everywhere, a lot of amateurs were made directors of civilian defense activities. Somewhere in the Hopley Report, the point should have been made that we were not going to create any new reservoir of experienced persons by the simple means of starting a new organization. The persons with the know-how are going to be too few at best and should not be bedevilled with well-meaning amateurs as bosses or assistants.

The Hopley Report contains some twenty-one subdivisions. For the most part, each of these deals with a specialty: fire, police, engineering, research, and so on. There is not space to comment on each of these, even if I were competent to do so. Insofar as these statements were prepared by persons with experience in the special field, they are useful descriptions of things for which to provide as a part of civil defense planning. They are not accompanied by an over-all estimate of staffs required for all these specialties if all local communities, all states, and all federal departments logically carried out the described functions and activities. For broad application, these functions and activities imply a heavy drain on available manpower.

To narrow down the requirements for manpower, the areas of strategic vulnerability must be defined and the physical vulnerability of these areas to various possible weapons must be determined.

REGIMENTATION

AS I WAS one of the group of thirty-five fire consultants called in by Mr. Hopley and his staff, I had a chance to see how the subject was being approached. From this I feel that most criticisms directed to parts of the Hopley Report have been unjust. I believe that Mr. Hopley and his staff made a conscientious effort to produce something useful within the limits of the terms of reference given them. Walter Winchell's criticism was particularly unfair, since he took sentences and phrases out of their context to make his points. That Mr. Hopley or his staff ever envisioned anything like a "gestapo" as a part of civil defense is an absurdity. Winchell's comment is best explained by the fact that it appeared to be a matter of policy with him to take a crack at anything sponsored by the Secretary of Defense.

Finding no very impressive documentation in the Hopley Report itself, Winchell fell back on a perfectly valid fundamental consideration. Regimentation is clearly one of the dangers inherent in organization for civil defense. This is not a danger brought about by the Hopley Report. It is a general problem of civil defense. As a principle, the less regimentation, the stronger the nation. A general problem of civil defense is to carry out certain measures and at the same time avoid all time-and-energy-consuming rigamarole which is inherent in regimentation. For example, plans for handling the movement of persons in urban areas must be worked out so that when weapons are used, the persons killed may be identified and buried, the injured hospitalized, and unhurt persons provided with food and shelter. There are large numbers of people to move, and the civilian problems are staggering. By comparison, the business of setting up an army, navy, or air force for national defense looks easy.

When a city is bombed out, one cannot go to the corner grocery for food. Where does the city-dweller go? To a bureaucratically administered commissary and supply system? I do not think we can afford to keep such a system standing by. We had better plan how to plug the gaps in our normal system for food distribution which may be produced by bombing.

After the Texas City disaster, one problem was identification of the hundreds of dead. Previous registration and fingerprinting of these people would have helped. In war there would be similar problems. Should everyone be registered and fingerprinted? Or would this lead to a lot of needless regimentation, such as a requirement for permits for movement from one community to another?

These are problems of civil defense which cannot, I believe, be settled by a few people. They can be solved only when they are widely understood and studied in the light of over-all national defense plans.

WHAT IS NEEDED IN A MILITARY SENSE

I KEEP coming back in my own mind to the need for a competent military statement about what sort of civil defense we are to provide. This seems to me to be something that should come from our Military Establishment. It is one thing which is clearly a military responsibility, yet it is the one thing the military has not provided. The Hopley Report does not provide such a statement. Before anything intelligent can be done about civil defense, a considered military estimate is needed of what bombs will fall (or what other weapons used), and where, and when. I am also aware of the difficulties the preparation of such a statement would involve. Every military man does not understand high explosive bombs. Incendiaries are a new weapon. Even today the relationship of these weapons and the physical vulnerability of prospective targets is not generally understood. I do not imagine many military people know very much about the effectiveness of atomic bombs. On some of the other terrifying potential weapons of modern war, the information may all be in the hands of a few technicians.

Civil defense must be planned with

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CIVIL LIBERTIES OF SCIENTISTS: REPORT OF AAAS COMMITTEE

The following report contains the conclusions and recommendations of a Special Committee on Civil Liberties for Scientists appointed in 1947 by the American Association for the Advancement of Science. Maurice B. Visscher was chairman of this committee, with Philip Bard, Robert E. Cushman, Richard L. Meier, and James R. Newman members, and Walter Gellhorn consultant. The entire report will be distributed by the AAAS when editorial revision is complete.

THERE is at present a tendency in public thinking to relate scientific activity almost wholly to military activity, exposing scientists more than most occupational groups to sustained and stringent limitations upon their professional freedom. Fearful lest these limitations exceed justifiable bounds, jeopardize the national welfare, and infringe the rights of scientists, the American Association for the Advancement of Science, in December 1947, created a Special Committee on the Civil Liberties of Scientists.

The present report embodies its conclusions and recommendations with respect to three main areas:

1. Restrictions on research and scientific information;
2. Measures to assure the personal reliability of scientists having access to confidential data;
3. Inquiries relating to the "loyalty" of scientific workers in federal employment.

I

Secrecy is damaging to both science and democracy. In both, progress and the detection of error depend upon open discussion and free interchange of ideas among widely divergent and widely separated groups.

Yet today, in the United States, we have within the body of science large regions of secrecy. We endorse the statement of the President's Scientific Research Board, which in its 1947 Report on Science and Public Policy said: "Strict military security in the narrow sense is not entirely consistent with the broader requirements of national security. To be secure as a nation we must maintain a climate conducive to the full flowering of free inquiry. However important secrecy about military weapons may be, the fundamental discoveries of researchers must circulate freely to have full beneficial effect. . . . Security regulations, therefore, should be applied only when strictly necessary and then limited to specific instruments, machines or processes. They should not attempt to cover basic principles of fundamental knowledge."

II

No matter how the area of secrecy may be delimited, there will undoubtedly remain some matters of scientific cognizance which should be kept confidential. So long as national policy dictates that secrecy be observed, the reliability of persons to whom these matters are entrusted must be assured; hence inquiries into the character and attitudes of these persons are warranted.

If national as well as individual interests are to be protected, however, improvements must be achieved in the policies and procedures of our present security clearance programs as they affect scientists who will be entrusted with classified information.

The Atomic Energy Commission and the National Military Establishment are the chief agencies concerned with the trustworthiness of scientists who have access to "restricted" or "classified" data. Neither of these agencies furnishes the affected scientist any statement of the reasoning underlying a conclusion which is adverse to him; neither one sets forth charges in a precisely formulated fashion; neither one requires that testimony used against an individual be made known to him, or that even casual and non-official informants be identified and produced for examination; neither one provides for the making of specific findings of fact; neither one undertakes to record and publish its opinions in a way which makes possible any public understanding or analysis of the determinations made.

In some respects the procedures of the Atomic Energy Commission are more fully elaborated than those of the National Military Establishment, though the military clearance of the latter may affect literally millions of employees of private industry engaged in the planning or production of articles for military use. A military determination that clearance should not be granted a civilian scientist is subject to appeal to the Industrial Employment Review Board (IERB), composed of Army, Navy, and Air Force officers. Proceedings of the IERB are themselves "classified," which means that even the immediately affected employee is forbidden to discuss them, keep notes about the handling of his own case, or possess a copy of the record of the hearing. Despite the fact that its decisions have a drastically important impact upon the lives and careers of civilians entirely outside the public service, the tribunal is exclusively military in its composition and there is no opportunity for review of its judgment by an appellate body differently constituted. Such subjection of the destinies of civilians to military tribunals is contrary to national tradition. Quite apart from procedural inadequacies, the present organization for deciding security clearance cases is open to basic criticism.

The Atomic Energy Commission has recently manifested a tendency to require security clearance not only for those scientists who themselves have access to restricted data, but also for their fellow scientists with whom they may have personal contact. This is graver in its implications than even the serious procedural and administrative imperfections already noted. At Brookhaven National Laboratory, for example, where only perhaps one-tenth of the scientific personnel works within the area of secrecy, all scientists must be cleared as a condition of employment. This apparently reflects a yielding to uninformed or sensationalist legislators and others who tend to exaggerate the problem of "keeping our atomic secrets." The effect of the excessive precautions is to discourage participation in important research activities closely linked to the nation's well-being. Scientists are increasingly reluctant to commit their personal and professional reputations to those who have brought frivolous charges against

respected colleagues. Moreover, the delays and expense often involved in obtaining security clearance deter qualified persons from entering the atomic energy program.

So far as disclosures of evidence reveal, the problem of faithless scientific personnel in this country appears to be markedly less grave than the public has been led to suppose. Moreover, informed scientists are in broad agreement that restricted data cannot be readily transmitted to unauthorized persons. In the circumstances which exist rather than those which are fancied to exist, the stringent application of personnel security clearance should be limited to smaller numbers of scientists rather than extended to ever larger groups. If nothing is done to reverse the present trend to require security clearance of scientists who do not have or desire to have access to restricted data, it is likely that many of the most penetrating and original scientific minds will be turned to pursuits unrelated to further development of the atomic energy program. Work in that field will be shunned by men of ability and pride if they are constantly treated as objects of suspicion and possible calumny.

III

Executive Order No. 9835 provides that no person shall be employed in a federal post if he is believed to be disloyal to the government of the United States. This Loyalty Order does not supplant existing provisions for summary removal of employees on security grounds. Entirely without reference to security considerations, the Order seeks to assure "complete and unswerving loyalty to the United States" on the part of all those who are in its service.

No one doubts the importance of faithful discharge of duty by public officials. No one questions the propriety of the government's demanding that its employees be loyal to their jobs and to the democratic institutions they serve. The Loyalty Order is, however, basically objectionable because it seeks to determine the employee's loyalty by inquiring into his supposed thoughts and attitudes, which are established in large part by imputing to him the beliefs of his associates.

If the Loyalty Order is to be retained, a drastic revision is essential. Instead of focusing on an employee's associations, it should focus on his behavior in overt acts. Legislation already on the statute books amply protects the federal service against retention of employees who advocate overthrow of the government.

Insofar as the Loyalty Order purports to deal with such matters as espionage, sabotage, and disregard of instructions, it is wholly superfluous, since conduct of that character is not only criminal but is also fully subject to administrative disciplinary action under existing law and regulations. The failure to confine the Loyalty Order to matters of objective proof has engendered a feeling of insecurity in public employment and may be expected to lessen the vigorous intellectual independence which is a prime condition of sound scientific work as it is of an imaginative civil service. "Experimentation there may be in many things of deep concern," Judge Cardozo once wrote, "but not in setting boundaries to thought, for thought freely communicated is the indispensable condition of intelligent experimentation, the one test of its validity." Unless there is elimination of the Order's present emphasis on attitude rather than conduct, the nation will suffer heavily from the present loyalty program.

Even if the Loyalty Order were to be continued without revision of its underlying philosophy, important changes in administrative methods are urgently needed. The present loyalty boards discharge simultaneously the functions of advocacy and adjudication. The content of the charges they issue and the conduct of the proceedings over which they preside do not assure that the facts and their implications will be fully explored. The organizations with which an employee may be identified are finally and conclusively characterized by the Attorney General without either the employee's or the organization's having any opportunity whatsoever to establish that the Attorney General was not fully informed. These and other procedural deficiencies can be corrected. So long as they remain, they accentuate the possibility of error in the loyalty program.

The fundamental shortcomings in the Loyalty Order, however, are not procedural. Rather, they are to be found in the very conceptions which the Order expresses. Refinement of administrative methods and gentility of official behavior are important, to be sure. But they are not basic. Until the Loyalty Order deals with the way employees act, rather than with the way they supposedly think, we shall inhibit the freedom and encourage the insecurity of our public servants. The cost will in the end be borne not by the employees who are deprived of their normal freedom to believe and behave as they wish within the limits law has set. It will be borne by the nation as a whole.

As President Truman recently asserted, "Continuous research by our best scientists is the key to American leadership and true national security. This work may be made impossible by the creation of an atmosphere in which no man feels safe against the public airing of unfounded rumors, gossip, and vilification."

FAS Scientists' Committee on Loyalty Problems Suggests Improvement in Clearance Procedures

The following communication has been received from Mr. Lyman Spitzer, Chairman of the Scientists' Committee on Loyalty Problems of the Federation of American Scientists.

THE Scientists' Committee on Loyalty Problems has been studying the loyalty and security clearance procedures of different government agencies for some time. While these procedures could be improved in many ways, the Committee wishes to point out to scientists that they themselves, even under present procedures, can better the situation.

The following proposal aims at raising the level of the confidential reports on which clearance decisions are based. In most investigations, agents of the FBI obtain information from friends, neighbors, and colleagues of the person to be cleared, as well as from less direct sources. The results are collected in a confidential dossier in which the sources of information are often anonymous or revealed only to a very limited number of officials. It is obvious that these unacknowledgeable statements can cause serious misunderstanding which cannot easily be clarified, especially in cases where the clearance status meets with difficulties.

It is, therefore, strongly recommended that all scientists adhere to the following rules whenever possible.

1. When giving information to loyalty and security investigators, state willingness to testify if necessary.

2. Prepare a signed, written statement of the information for the investigating agency.

THE PRICE OF OUR SURVIVAL

Michael Amrine and
Edward A. Conway

The Reverend E. A. Conway, S. J., and Michael Amrine, former director of public education at Brookhaven Laboratory, here analyze our present danger and the measures it demands. This article first appeared in the October 8 issue of AMERICA and is reprinted, in a somewhat shortened form, with the kind permission of the editor.

AN ERA died, an era only four years old, when President Truman announced on September 23 that "within recent weeks an atomic explosion occurred in the USSR."

We sympathize with prominent people pinioned by the press without warning and asked for comment on this or that emergency. We were nonetheless shocked when a man as respected for his perception as Dwight D. Eisenhower, president of Columbia University, said flatly: "I see no reason why a development that was anticipated years ago should cause any revolutionary change in our thinking or in our actions."

We were shocked even more by the statement, obviously carefully considered, of a man most qualified to comment, a man whose understanding of human relations we have always admired—David E. Lilienthal. According to United Press, the AEC chairman said that this country must do everything necessary to "establish unquestioned and unmistakable leadership" in an atomic armament race. Mr. Lilienthal said he felt now precisely as he felt before he knew Russia had the bomb. He then referred to a July 6 statement in which he had said that by maintaining that leadership we could "buy time for reason to prevail." He added that "numbers and not simply the first atomic weapons are the crucial item."

For once Mr. Lilienthal finds himself side by side with the Hearst press. Here is the Hearst-simplified version of the Lilienthal doctrine:

"The U.S. is making what amounts to TWO BOMBS EVERY DAY. America has an enormous jump on the USSR. The U.S. can make the cold war even colder by staying ahead of the Russians. America had a slogan some years ago. It was: "Two ships for every one," and in time its observance enabled her to win the greatest war in history. It would be a good slogan to revive. It would also be good for America to coin a new slogan to fit these times. It is one which, if strictly observed, could enforce the peace of the world: FOUR BOMBS FOR ONE!"

Suppose that by 1952 (remember, that was when the Russians were going to have bombs) we have 1,600 bombs and the Russians have 400. Would that give us any actual strategic advantage over them?

No. Why not? Because the Russians could do as much damage, if not more, with their 400 bombs as we could with our 1,600.

Mr. Lilienthal said further that we must keep our atomic leadership in order to "buy time for reason to prevail."

This theory is based on an untenable psychological assumption, that two peoples will stay sane and calm and reasonable in the midst of an ever-accelerating atomic armament race.

The central sobering facts about our present predicament are these: There is no safety in numbers of bombs. Nor is there any long-term safety in air power, in radar screens, in rocket interception. Science got us into this predicament, but science cannot save us.

We have no pat solution to offer, nor are we proposing any particular leadership. But we are asking for *real* leadership, the best that can be found in America.

While the search for that real leadership proceeds, we might start at once on this interim program:

1. A national act of humility, which is nothing more that honest acknowledgement of the truth. Out of this humility should come caution and the spirit of compromise. Caution will counsel an end to boasting, blustering, bullying and blackmail. The spirit of compromise is needed, now that negotiations will be conducted by equals, in power if not in probity.

2. Mobilization of the best physical, social, and political scientists in America for a supreme, cooperative, national effort to work out a viable atomic policy.

3. A thorough re-evaluation of the personnel that has been setting and executing our atomic policy. No respecting of persons, prestige, or political power must prevent the selection of top-drawer personnel.

4. Re-study of our entire atomic policy, both national and international.

Nothing less than revolutionary changes in our thinking and in our actions is going to satisfy the American people, who, after all, like to sleep at night. When they come out of their present state of shock, they are going to ask for those changes. Leadership worthy of the name of leadership would not wait to be asked.

Lilienthal and Commission Cleared

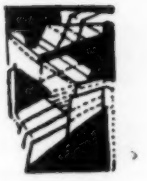
On October 12, the Joint Congressional Committee on Atomic Energy, by the votes of nine Democrats to six Republicans, absolved the AEC and its chairman, David Lilienthal, of the charges of "incredible mismanagement," "maladministration," and "waste," brought by Senator Hickenlooper of Iowa.

The majority report found that the Commission had attained a working balance between "security of concealment and the security of achievement." It praises the AEC for "taking a vast enterprise which was falling apart at the seams and reshaping it into a formidable deterrent against aggression."

Senator Hickenlooper and the five other Republican members of the Committee have filed a minority report, signed by all Republican members except Sen. Vandenberg and Rep. Hinshaw.

The *Bulletin* hopes to present a summary of the reports in a future issue.

ATOMIC POWER IN SELECTED INDUSTRIES



Sam H. Schurr

The following article is based on a chapter of a forthcoming book, "Economic Aspects of Atomic Energy," reporting the study conducted by the Cowles Commission, of the University of Chicago, under the direction of Professor Jacob Marschak and Mr. Schurr. The economic aspects of atomic power have been discussed in the BULLETIN by Jacob Marschak (February 16, 1946 and September 1, 1946), by Sam Schurr in an article published in April, 1947, and, most recently, by Walter Isard and Vincent Whitney in the March, 1949, issue.

THIS article, based on a series of industry analyses, is a preliminary summary of one phase of a broader study of the possible economic effects of atomic energy conducted by the Cowles Commission for Research in Economics.[1] It is frankly exploratory—as indeed is also the broader study. The findings reported here are not to be thought of as *predictions* of how these industries will be affected by atomic energy, but rather as *approaches* to understanding the industrial implications of atomic energy.

A series of industry analyses has two broad purposes. It should, of course, provide information which will be useful in charting the course of individual industries under the impact of atomic power. That much is obvious. But it should also help us understand the general effects of atomic power on the entire economy. The answers to questions about the impact of atomic power on the economy of the United States or other countries—and, indeed, in some cases merely the posing of the proper questions on this subject—can, in good part, be found only in detailed industry-by-industry analyses.

The industry studies summarized in this article constitute no more than a beginning to the kind of analysis which will have to be undertaken if we are to grasp the economic implications of atomic power. Their main value, perhaps, lies in the formulation of the appropriate questions for individual industries and the construction of an analytic framework to handle those questions; in the tentative assembly and analysis of relevant economic and engineering data which permit the preliminary sorting out of the industries concerned into those which might and those which probably would not feel important effects as a result of atomic power; and in the insights gained about the general effects of atomic power on the economies of the United States and other countries.

Despite the fact that they are tentative, these industry studies should go some way toward meeting the need for guidance of the sort referred to in a recent report of the Industrial Advisory Group appointed by the United States Atomic Energy Commission:

> We think that today the central difficulty in getting a broad industrial attack on the problems of atomic energy is the fact that industry has no way of determining whether important opportunities in fact exist in which to take part . . . It has been stated that industrial opportunities in atomic energy are potentially unlimited. But they are at present so shadowy that *business men neither know where to look nor what to look for.* Today no one can say whether the prospects of profits or other incentives exist, because under present conditions the great majority in industry know little or nothing about the subject.[2]

We shall first set up the problem so far as the industry analyses are concerned, then report some of our major findings in selected industries, and finally discuss briefly their significance for more general economic questions.

THE SETTING OF THE PROBLEM

WHILE we have tried to follow a uniform pattern in all of the industry analyses, we have had to modify the pattern in many different ways because each industry is in certain respects unique. The stress placed on different aspects of the problem varies from one industry to the next, and the specific questions to which we seek answers are not always the same. Nevertheless, there are certain major questions which embrace our primary interests.

The first major question is obvious. Since atomic energy may be available at a lower cost than some of the energy sources commonly used today, we ask: Will industries in which energy is an important element in costs experience cost reduction as a result of using atomic power?

There is a second question related to the first one. In some industries where energy cost is important, atomic energy probably cannot be used without changes in production techniques. The only production processes in which atomic energy obviously can be used without any change are those which are now based on electricity, since it is generally assumed that atomic energy will appear commercially as electrical energy. Other processes now based on the burning of ordinary fuels (e.g., residential heating) or on particular chemical reactions (e.g., iron smelting) will require modification. For these industries we ask: Will atomic energy encourage the introduction of new production techniques?

A unique feature of atomic power is that it will not be characterized by the geographical variations in cost which are common for the energy sources used today. The reason for this is simple. Atomic fuel has so great a concentration of energy per unit of weight that we may say that for practical purposes it is a weightless fuel with cost-free transportation. Geographical variations in power costs may, of course, still arise from such factors as differences in the size of central electric stations from place to place, differences in the costs of constructing central stations of a given size, and so

The above article appears in a more extended form in the *Harvard Business Review*, July, 1949. Permission to use the portions appearing here has been given by the editor.

1 In this article the individual industry reports made by George Perazich, Milton Searl, and Harold H. Wein have been drawn upon as indicated in footnotes to the industry summaries. The present analysis is confined to atomic energy as a source of heat and power; it does not consider the economic importance of any other products of nuclear fission.

2 Published in the *Bulletin* V (February, 1949), 51-55.

forth; but in the main these variations are expected to be small, and possibly short-lived, compared with the varying costs for coal transportation and the natural differences governing the cost and availability of water power.

The likelihood that the cost of atomic power will tend to be geographically uniform suggests the third major question to be considered. In some industries the availability of low-cost fuel and/or power, or the availability of an unusually suitable fuel, has been highly important in the selection of factory sites. The question arises, therefore, whether under the influence of virtually equal-cost atomic power the locational pattern in these industries would change in favor of new sites possessing advantages not held by areas near low-cost fuel and power.

The analysis by industries, then, centers on three primary questions: (1) the possibility of cost reductions in industries which today consume much energy per unit of product; (2) the possibility that low-cost atomic power might encourage process changes in which methods based on atomic energy would substitute for the direct fuel-burning or chemical methods used today; and (3) the possibility of changes in location of some manufacturing activity as a result of the geographical equalization of power costs. Of course, the effects which atomic power might have on individual industries would often fall within two of these general categories, since a process change might occur in conjunction with either one of the others.

Selection of Industries

THE industries selected for examination in line with these three questions are aluminum, iron and steel, railroad transportation, and residential heating.[3] In each of these, the cost of energy is an important element in total production costs, so that reductions in cost through the use of cheaper energy could be significant. In addition, energy resources have influenced production locations in two of the industries—aluminum and iron and steel; therefore, possible relocation of production as a result of atomic power is to be examined for them. Finally, in iron and steel, railroad transportation, and residential heating, the widespread use of atomic power would depend on the adoption of production processes quite different than those generally used now, since in none of these is electricity the primary energy source today.[4]

Two preliminary points should be noted. In comparing a new production process based on atomic power with a method in current use, and in comparing a new production site with an existing production site, we use total costs as the relevant measure (unless otherwise specified). Part of the total costs with existing methods and in existing locations represents current charges on a fixed investment. Since the investment cannot be recovered, these costs must be disregarded in any comparison of existing plants with new plants. In actual practice, therefore, when we speak of changes in location or changes in process, we usually have in mind a situation where new facilities are to be constructed to take care of increased demand or to replace worn-out existing facilities.

The reader should be aware, too, that our relocation calculations (unless otherwise specified) assume that the cost items other than energy and the cost of transporting the raw materials and the finished goods are the same in the hypothetical new site as in the old. This is done because figures on these other costs at new locations generally are not available and cannot reliably be estimated except through an intensive study of a particular site—a task considerably beyond our resources. The sites we select in our examples should not, therefore, be taken as the precise places in which new production locations might develop, since other costs may be unfavorable there. Instead, they are meant to illustrate the kinds of regions to which production might move if other costs are not unfavorable.

Cost of Atomic Power

OUR industry analyses start from a set of ideas concerning the cost and other economic characteristics of atomic power. Some of these are mentioned elsewhere in connection with specific questions. Others, which are particularly relevant to the industrial analyses, will be briefly stated in this section. These relate mainly to the cost of producing atomic power.

According to the estimates we have derived,[5] the cost of generating commercial atomic electricity might fall into one of the following classes (assuming 1946 prices and electric central station operations at 50 per cent of capacity):

4.0 to 4.5 mills per kilowatt hr. (KWH)
6.5 to 7.5 mills per kilowatt hr. (KWH)
about 10 mills per kilowatt hr. (KWH)

We have evaluated these estimates in terms of an approximate time scale of commercial use. The highest figure we take to represent the level of cost which would be typical of the first commercial plants producing atomic power. The lowest figure, on the other hand, we consider to represent the minimum cost at which atomic electricity would ever be produced by techniques considered likely at the present time. We believe costs would fall this low, if ever, only after the commercial atomic power industry has had many years of experience. The intermediate cost figures we consider to represent an approximation of the level of costs which might prevail in those atomic power plants which will be built,

3 For the analyses of an additional five industries—chlorine—caustic soda, phosphate fertilizer, cement, brick, and flat glass—and for a more complete explanation of the selections of industries, see author's article in *Harvard Business Review* (July, 1949) pp. 459-79.

4 By "process change" we mean (and this is a specialized definition) the use of atomic energy, either as direct heat or as electricity, in an industry where electricity is not now the primary energy source. We define process change in this way because if useful atomic power appears as electricity, it can be used with absolutely no change in method wherever electricity is now used. For example, it would make no difference in aluminum reduction whether the source of electricity is a nuclear reactor or a waterfall. However, for those industries which obtain energy from coal or some other fuel, it would usually make a great difference if their energy source were changed to electricity. A production technique which is novel in at least some respects would be required. The difference might be less drastic where the nuclear reactor is used as a source of heat rather than of electricity, but even here quite important changes might be required in production technique. For example, the substitution of nuclear heat for coal in residential heating would require the establishment of district heating systems to replace the home furnace.

5 The estimates are based on the figures in several published studies of the cost of atomic power. Their derivation is not explained here because of limitations of space, but a complete explanation of methods and assumptions will appear in our final report. Although the estimates are still subject to change before the final report is published, we do not expect that the changes, if any, will be serious. The costs as shown are for electric energy, but equivalent nuclear heat costs have been used where the industrial process involved would be based on the direct heat of nuclear fission.

say, five to ten years after the first installations. These plants would incorporate the improvements based on the lessons learned in constructing and operating the earliest plants but would still fall short of the highly efficient designs which would incorporate the advances of a good many years of commercial operation. For the purposes of the industrial analyses only the low and intermediate estimates are significant; as long as the highest cost prevails, there are not likely to be any important industrial effects.

It must be understood that the cost figures are only rough estimates. Therefore, even though we believe that they can best be understood as applying to different stages in the commercial use of atomic power, it is also possible that any one of them could materialize as the real long-run cost of producing atomic power, depending on how the many unknown factors shape up in the process of development now under way. The firmest figure, perhaps, is the estimate below which atomic costs are not expected to fall, for this is based on the assumption that the investment per kilowatt in atomic electricity would ultimately be as low as the investment in ordinary thermal electricity. The only remaining difference, in this event, would be in the cost of the fuel "burned" in the two types of plants.

Additional important characteristics of atomic power can be seen when the estimate of generating costs is shown in terms of its component items. For this purpose we take the two lower cost classes since only they are significant in the industrial analyses. Their breakdown into fixed charges, fuel, and labor, maintenance, and supplies is shown in Table 1.

TABLE 1
ELEMENTS OF TOTAL COSTS OF ATOMIC POWER
(In mills per KWH)

	Minimum Estimate	Intermediate Estimate
Total cost	4.0 — 4.5	6.5 — 7.5
Fixed charges	3.5	5.8
Fuel	0.002–0.02	0.002–0.02
Labor, maintenance and supplies	0.5 — 1.0	0.7 — 1.7

Two major factors are revealed in this breakdown of estimated costs: (1) Fixed charges dominate in production costs; and (2) the cost of fuel is of negligible importance. The fuel item considered here is the day-to-day consumption of natural uranium or thorium. These fuels consist almost wholly of materials which are not fissionable in their natural state but which have the rare property of being converted into fissionable substance when exposed to fission in the nuclear reactor. The reactor probably will require, in addition to the natural uranium, the investment of an initial stock of some pure fissionable substance (plutonium, Uranium 235, or Uranium 233) in order to begin operations. This will be relatively costly, but it figures only as an item in the initial capital cost per kilowatt of capacity and is covered in the fixed charges on investment. We assume, admittedly on evidence that is inconclusive at the present time, that the reactor will replenish its supply of such materials through its own operations by converting feed materials (natural uranium or thorium) into fissionable substance.

These factors have at least two implications for the industry analyses. The first pertains to the question of the percentage of capacity at which the atomic power station operates. The costs shown are for operations at 50 per cent of capacity, a reasonable average figure for total electricity production. Since fixed charges are so important, however, substantial cost reductions per KWH are possible if capacity is more fully utilized. Many of the industries we consider in our discussion will be characterized by an almost continuous and unvarying energy demand, so that they will use a kilowatt of capacity almost 100 per cent of the time. For these industries, lower estimated KWH costs reflecting the fuller utilization of capacity are used in our analysis. Total costs per KWH at 80 per cent and 90 per cent of capacity (100 per cent of capacity is rarely attained) as compared with costs at 50 per cent are shown in Table 2.

TABLE 2
COMPARISON OF COSTS OF ATOMIC POWER WITH OPERATIONS AT VARIOUS PERCENTAGES OF CAPACITY
(In mills per KWH)

Percentage of capacity	Minimum Estimate	Intermediate Estimate
50	4.0–4.5	6.5–7.5
80	2.7–3.2	4.3–5.3
90	2.5–3.0	3.9–4.9

A second important implication is that the cost of producing atomic electricity[6] is likely to remain very much the same over the lifetime of an existing atomic power installation. This would sharply distinguish atomic electricity from ordinary thermal electricity if the upward trend in the cost of conventional fuel continues, since rising fuel costs would result in higher electricity costs. In this respect the atomic installations will resemble hydroelectric plants since for them fixed charges are also the dominant element in costs.

[6] All of the figures we have shown so far are estimated costs for the generation of atomic power, exclusing costs for transmission. We allow for transmission implicity by assuming that the border line of realizable atomic costs will fall somewhere between the minimum and the intermediate estimates, and in no case at the estimated absolute minimum. We have, in effect, a cost zone of about one-half to one mill per KWH (at 90 per cent capacity) into which we relegate transmission along with other uncertainties surrounding the cost estimates. The exception to this procedure among the electricity-consuming industries is railroad transportation. Here we make explicit allowance for transmission because of the obvious need in this industry for moving electricity over extended distances.

MAJOR INDUSTRY FINDINGS

THE following summaries report several of those findings of our industry studies which we consider most significant, as they apply to the United States. (In our detailed industry discussions in the full report we attempt, wherever the results warrant it, to weigh the implications for other countries also.) The reader should be aware that we have often found it difficult within the limits of a brief summary to convey fully the tentative nature of our conclusions or to provide adequate information on the shortcomings of the primary data.

Aluminum

THE aluminum industry consumes an extremely large amount of electricity per ton of product. The electricity input—about 18,000 KWH per ton—is the largest among the industries covered here. The size of the per unit power requirements has forced the industry to seek sources of extremely low-cost electricity for aluminum reduction works. These have usually been near hydroelectric power. The orientation to cheap power has meant that additional costs have been incurred in the production and marketing of aluminum both for the transportation of raw materials (two tons of bauxite per ton of alumina, and two tons of alumina per ton of aluminum) to production centers, and for the transportation of pig aluminum to consuming centers.

We have considered three primary questions: (1) Could atomic power reduce costs in existing production locations? (2) Could it bring about changes in production locations either closer to aluminum markets or bauxite deposits as a result of a greater geographical equalization of electricity rates? (3) Could it be important to the continued growth of the aluminum industry by providing a cheaper future source of electrical energy than would otherwise be available?

We find that lower costs at existing sites are not likely to result from atomic power, since the industry is already using energy sources which produce electricity more cheaply than appears possible for atomic power plants.

THE possibility of relocating aluminum production to two new sites was considered: (1) Dutch Guiana, which provides the bulk of the bauxite consumed in the United States; and (2) Mobile, Alabama, which is closer to bauxite resources and also closer to important markets than some existing aluminum plants, and which is now an important center of alumina production (an intermediate stage in making aluminum from bauxite). Assuming that existing aluminum production locations continue to provide a growing supply of equally low-cost power in the future as in the past, relocation to the new centers would require atomic power rates of about 3.5 mills per KWH or less in Dutch Guiana and 3.25 mills or less in Mobile. Since such rates are on the border line of estimated realizable atomic costs, we have concluded that, while locational shifts might occur as a result of atomic power, they would not bring about major reductions in aluminum prices.

Whether atomic power could provide a cheaper future source of electric energy than ordinary power depends in the main on four variables: (1) the estimated future demand for aluminum if relative metal prices remain as they are today; (2) the future availability of water power sites with favorable natural conditions; (3) the future costs of constructing hydroelectric developments; and (4) the future costs of alternative fuels that might be used for generating electricity.

The variables can be combined into the following composite picture: Estimates of future aluminum demand by some experts indicates that something like 3.5 million additional kilowatts of capacity might be required to satisfy the growth in aluminum output between 1945 and 1970. This amount, which is about four-fifths of the total generating capacity of all federally owned hydroelectric plants in 1946, would have to be made available in the face of the possibility that unused water power sites may, in general, have less favorable natural conditions than those already exploited. Furthermore, the cost of constructing hydroelectric developments probably will be higher in the future than in the pre-war decade. As a result of higher construction costs alone, alternative sources of electricity of 3.9 mills per KWH or less in the Gulf Coast area would provide cheaper aluminum in important markets than additions to hydroelectric capacity at existing sites.

While rates of 3.9 mills might make ordinary thermal electricity plants fueled by natural gas suitable for aluminum production, there are several reasons why these plants would be less effective in attracting aluminum production than atomic power:

1. The future cost and availability of natural gas is uncertain, while atomic power costs should be pretty much the same over the lifetime of an installation. This is important because rising fuel costs, and the resultant higher electricity rates, could be disastrous for aluminum producers with their very high power consumption per unit of production.

2. Potentially, atomic costs can fall below costs possible with natural gas except when the latter is an almost cost-free by-product of oil field operations for which there is no other market.

3. Thermal power stations based on natural gas would be locationally inflexible as compared with atomic power. Natural gas happens to be cheap on the Gulf Coast, but this is only one of many sites at which aluminum might be produced. Sites even closer to important markets might have lower aluminum production and transportation costs than Mobile, particularly if aluminum production from fairly ubiquitous low-grade clays became technically feasible. On this basis, the New York area, or other important market centers, might attract aluminum production with atomic power, but not without it.

We conclude, therefore, that atomic power may be of great importance in supporting the future expansion of aluminum output in the United States, undoubtedly in locations other than those favored by aluminum producers today.

Iron and Steel[7]

IRON ore smelting today is completely dependent on coal in the form of coke. For this purpose coal acts both as a source of heat and as a chemical agent. Energy (not necessarily from coal) is also required in the later stages of steel manufacture, including steel refining and rolling. The over-all fuel economy involved in combining coke ovens, blast furnaces, steel furnaces, and rolling mills has resulted usually in creating works where all of these operations are carried on at a single site. When these operations are taken together, it becomes clear that coal is important not merely as a source of blast furnace fuel but because it also has a powerful locational influence on the entire integrated operation. Iron and steel manufacture takes 15 per cent of all the bituminous coal produced in this country (chiefly for blast furnace use), and also consumes large amounts of other fuels in steel furnaces and rolling mills.

COULD atomic power alter this situation? It would appear that it could only bring about change in one or both of the following ways: It might either replace coke as a blast furnace fuel and thereby release the entire operation from its fundamental dependence on coal; or it might separate the steel furnace and rolling mill from the blast furnace and produce important effects only on the later operations which can be based on electricity with present-day technology. We consider both possibilities in our analysis.

With respect to the separation of steel furnaces and rolling mills from the blast furnaces, the analysis discloses the following possibility. Atomic electricity might make the electric melting of steel scrap worth while in important steel-consuming centers which do not today have steel plants or which produce much less steel than they consume. In other words, atomic electricity rates might be low enough so that, together with the transportation savings possible from locating production close to market, they would make such furnaces competitive with integrated steel works elsewhere.

This development is rendered much more likely by the recent announcement of the Republic Steel Corporation that continuous casting has been successful on an experimental basis. In this method only one step is needed for converting molten steel to semifinished shapes, so that the massive and expensive equipment needed for making ingots and billets is eliminated. Taken together with low-cost electricity, this might open the way to decentralized steel production in such important steel-consuming centers as New York, Boston, St. Louis, San Francisco, and Seattle.

Scrap supplies would set a definite upper limit to steel production by this method. Although the annual supply

[7] Summarized from materials prepared by Harold H. Wein.

of scrap is not likely to exceed 25 million tons at most for a long time to come, the economic limit to electric scrap melting probably would be considerably lower, since integrated steel works, which will continue to use open-hearth furnaces operating on a mixed charge of scrap and pig iron, will compete for the limited scrap supplies. Thus, while this development probably could bring about some decentralization of steel production, the bulk of steel production in the United States would continue to be organized on the present basis.

COULD electricity replace coke as a blast furnace fuel? We find that there is on the horizon one technique which might be economically feasible in the United States. In this method iron ore would be reduced to sponge iron by using hydrogen, rather than carbon, as the reducing agent. This new process, just emerging from the laboratory, is considered promising by the research metallurgists who have experimented with it.

Atomic electricity could be used to produce hydrogen by the electrolysis of water. We have raised two questions with respect to hydrogen reduction based on atomic electricity. Could iron be produced at a lower cost by this method than by the coke blast furnace in the present centers of steel production? Could the new method result in new iron production sites which would provide iron in important markets at a lower cost than do present locations? To answer these questions we constructed estimates of the comparative costs of iron production by the two methods. Obviously these comparisons are extremely rough since the hydrogen method has not yet been tried commercially.

Our calculations indicate that if the price of coking coal is about $8 per ton or more, atomic electricity used in the hydrogen process would be on the competitive threshold of the coke blast furnace. On this basis we find that existing steel production centers will continue to find the coke blast furnace a less costly source of iron than hydrogen furnaces based on atomic electricity.

Since coal is an important locational determinant for the coke blast furnace, it is to be expected that present steel centers will be favorably situated with respect to coal. In a process based on atomic electricity the major raw material influencing location would be iron ore, and we therefore have attempted to determine whether the hydrogen process based on atomic power near iron ore would be cheaper than the coke blast furnace elsewhere. Here we find that the iron ore region of northern Minnesota, which produces the bulk of the iron ore consumed in the American steel industry, might be able to deliver iron at a lower cost in the Chicago-Gary market than the steel plants located in this area, and could almost match costs in the Pittsburgh region.

This particular result rests on assumptions which may prove invalid particularly with respect to the relative costs of transporting iron ore and sponge iron. It points to the possibility, however, that atomic electricity might bring the hydrogen reduction process at new production sites within economic reach.

IF THE hydrogen process based on atomic electricity should be adopted, it might have major implications for the location and size of steel-producing facilities. Fuel economy would no longer be of such great importance, since the hydrogen reduction process would not yield anything like the volume of hot gases exhausted by the coke oven and blast furnace. This change would weaken one of the most important factors which has historically made for the locational integration of all operations from the coke oven through the rolling mill. If the new hydrogen process is used, it might prove possible to reduce the iron ore at the ore site, since iron ore would then be by far the bulkiest raw material requirement, and to place the later stages of production near the market for steel products. Furthermore, it appears possible that sponge iron operations could be successfully set up in a region to exploit ore resources of about one-fifth the size needed for economic investment in a blast furnace.

What might happen, therefore, is that iron reduction would over time undergo much decentralization with hydrogen sponge iron plants developing in various regions, based on local reserves of iron ore. Under these circumstances some integrated operations, on a considerably reduced scale, might return through the backdoor. For, as the economic size of the plant is reduced, smaller markets could be served by a single plant, and the market and ore site might draw closer together. Of course, the chances for such a development would be enormously improved by the perfection of continuous casting since this technique would scale down considerably the size of units required for converting the steel into certain basic shapes.

Railroad Transportation[8]

WHILE energy costs account for about 8 per cent of railway operating costs, other operating expenses are also affected by the type of railroad motive power used. The aggregate consumption of fuel by American railroads constitutes somewhat more than 10 per cent of the country's total consumption of mineral fuels. The energy consumed today is derived primarily from coal, although the trend in recent years has been in favor of diesel oil. This trend may reverse itself if oil costs continue to be very high, and if the recently developed coal-burning gas turbine locomotive compares favorably with the diesel locomotive. Electricity as a source of railway motive power accounts for only a very small percentage of the industry's total energy consumption.

It is conceivable that nuclear reactors could be used directly to propel locomotives, but we do not consider this a likely possibility because of a combination of technical and economic factors. Our main question is: Could atomic electricity encourage a significant increase in railroad electrification replacing fuel-fired locomotives? Our basic comparison is between electric locomotives using electricity generated in atomic central stations, and diesel locomotives, which are taken to represent the best in modern fuel-fired locomotives. The analysis considered only main-line locomotives traveling about 20,000 miles per year. In order to bring the subject within manageable proportions, we undertook only highly simplified comparisons from which only very general conclusions can be drawn.

The most important variables affecting the choice between diesel and electric locomotives are the comparative costs of diesel oil and electricity and the density of railroad traffic. Considering diesel oil costs in various parts of the country and the prevailing density of railroad traffic in the same regions, the electricity rates required to render electrification economically feasible were in most cases found to be below the minimum estimates of future atomic costs. For three regions (the Great Lakes, Central Eastern, and Pocahantas regions, as classified by the Interstate Commerce Commission),

8 Summarized from materials prepared by George Perazich and the author.

railroad traffic appeared sufficiently dense to justify possibly a fair amount of electrification, but only if atomic electricity could be made available at or near the very lowest estimated future cost, and if diesel costs remain at current high levels.

Since a significant expansion in railroad electrification based on atomic power probably could not be justified anywhere in the United States unless atomic electricity were produced at the minimum estimated future cost, the industry probably will not undergo extensive electrification as a result of atomic power. First of all, it is rather doubtful that atomic costs will fall to the very minimum. Second, if its costs were that low, atomic power might, according to our studies, replace coal in many of its current uses. Since coal tonnage constitutes about one-third of the total freight originated on American railways, there is, at least, a serious question whether, as a result of the decline in coal shipments, the density of railroad traffic might not in many cases fall below the minimum necessary to justify electrification. Therefore, the general conclusion seems warranted that railway motive power in the future, as in the past, will continue to be based on diesel oil and coal, the latter fuel possibly to be used in radically new locomotives.

Residential Heating[9]

A GREATER amount of energy is consumed annually in space heating than in any of the industries covered by our analysis. In 1945, the fuel consumed for this purpose accounted for almost 20 per cent of the total energy supply from mineral fuels and water power. (This total includes the heating of schools, hotels, offices, hospitals, and probably stores, but the analysis is confined to residential uses.) By and large, the heating of residences is not performed by an existing industry but by the individual householder or his landlord. How would nuclear heating affect this important energy use? Could it bring about the growth of a district heating industry using central nuclear reactors as its energy source? Or could it substitute for conventional heating methods in some other way?

In the other activities covered we have considered atomic power primarily in the form of electricity. We do not consider electricity for space heating purposes because (1) electric heating with ordinary resistance heaters is at a decided disadvantage in comparison with direct heat from the same thermal source, chiefly because of the energy loss involved in converting heat into electricity, and (2) the only electric heating device which could redress the energy loss involved in producing electricity, the heat pump, is today much too expensive for common use. Nor do we deal with the possibility that nuclear reactors whose primary product is electricity will supply direct heat as a by-product, because, at best, this could usually satisfy only a small part of a locality's heating needs. We confine the analysis to the possibility of district heating based on centrally located straight heat-producing nuclear reactors. Heat produced by an experimental nuclear reactor, which began operating at Harwell, England, in July, 1948, is reported already being used for space heating, though only within the confines of the Harwell establishment.

The most important variables affecting the cost of residential district heating are population density and weather conditions. In general, a combination of high population density and cold winters would be required to bring district heating into competition with conventional heating methods. This is mainly because there are decided economies of large-scale operations in the laying of underground pipe, so that a length of pipe to carry a load of, say, four times that of a smaller capacity pipe of the same length can be laid at about a 50 per cent increase in cost. Furthermore, since fixed charges dominate in costs, unit costs are reduced substantially in any size system as capacity is more fully utilized.

OUR analysis shows that the concentrated heating demand which would probably be required to bring nuclear district heating costs down to a competitive level exists in very few American cities. Some cities in which conditions appear to be satisfactory for nuclear district heating are Boston, Buffalo, Chicago, Milwaukee, and New York, and Newark, Paterson, and Jersey City in New Jersey. In all these cities the average density of population is over 13,000 persons per square mile. The lowest average density exists in Milwaukee, but the winters there are the coldest among the cities named. The others represent varying combinations of exceedingly high population density (New York) and quite cold winters (Buffalo). But all of them are marked by both characteristics to a considerable extent. Very cold winters alone, as in the case of Duluth, for example, would not be a sufficient condition for the success of nuclear district heating, nor would high population density as in some cities with mild winters.

For several reasons this listing of cities is highly tentative and, at best, merely illustrative of suitable locations. Actually the suitability of any locality for district heating could be determined only through an engineering survey of that locality. In the absence of such a survey, we have assumed certain typical values for the cost of laying pipes underground, the nature of the buildings to be heated, and so forth, which may be inappropriate for some or all of the cities shown. This is a basic technical problem with which we were unable to cope.

There is, in addition, a basic statistical difficulty which might have been overcome, but only with the expenditure of an amount of work completely beyond our resources. This difficulty arises from the use of city-wide averages on population density as a guide to the selection of localities suitable for nuclear district heating. City-wide averages are inappropriate because of sharp differences in population density among districts within a city. The cities we list undoubtedly contain some districts where the density is too low to justify district heating, while many other cities not listed include certain districts where population density would permit nuclear district heating.

Because of the shortcomings of our analysis, we draw only two very general conclusions:

1. Nuclear district heating might be available at a cost low enough to compete with conventional heating methods in some localities, the heating market thus served accounting for a sizable part of the nation's space-heating requirements. This may be seen from the fact that the cities listed above include about 10 per cent of the population of the United States. In terms of fuel consumed for space-heating purposes their percentage importance would be much greater, since a large part of the population of the United States lives in mild regions where relatively small amounts of fuel are used for space heating.

2. The substitution of nuclear district heating for conventional methods would not involve large cost savings. Instead, in most cases where nuclear heating would be competitive, its costs would be in the same general range as

[9] Summarized from materials prepared by Milton Searl and the author.

conventional methods, but nuclear heating might prevail because of its convenience.

GENERAL ECONOMIC QUESTIONS

THE general economic questions which the individual industry analyses may help us understand can be grouped most conveniently into two categories: (1) What are the resource-saving effects of the commercial use of atomic power; and (2) what new impulses to economic development might it generate? The two categories are not mutually exclusive since the economic development impulse may appear first as a resource-saving effect; we distinguish between the two in order to indicate at what points we think the developmental impulse may be particularly important.

Resource Saving

LET us try to see, first, what the individual industry analyses can tell us about the resource-saving effects of atomic power in the entire economy which we cannot learn from a less detailed approach to the problem. One way to estimate the resource-saving potentialities of atomic power — and this is a method which has frequently been used — is to take the total amount of electricity produced in the United States and to estimate what might be a reasonable unit cost reduction as a result of atomic power. The multiplication of total electricity production by unit cost reduction is used to make an estimate of cost savings (i.e., total resource saving) in the entire economy.

But this over-all or "global" approach to the measurement of resource saving has serious shortcomings. For one thing, it fails to measure the resource saving which might result from relocating production to more favorable sites as a result of the geographic equalization of power costs. Primarily this would save resources previously consumed in transportation (of materials other than fuel).

For another thing, it fails to take into account the fact that the level of demand for atomic energy may greatly exceed what might otherwise be the level of demand for ordinary electricity, particularly as a result of induced changes in industrial processes (perhaps along with changes in location) that would make nuclear power the major energy source where higher cost electricity cannot successfully compete today. The resource-saving calculation which would have to be made on this account would depend on the extent to which the change in process reduced production costs in the industries affected and created greater demand for their products.

It seems clear from our industry analyses, tentative though they are, that the over-all approach is definitely unrealistic. The actual resource-saving would be made up of possible cost savings in many different industries. No matter how great it might be in total, its realization would depend on the varying margin of advantage for atomic power in each individual industry, which determines whether a shift to atomic power is feasible there.

To be sure, the industry-by-industry approach must be elaborated and extended before anything approaching a final answer is reached. But, in the meantime, our preliminary investigations do give valuable insight, not only into the existence of many negative factors likely to slow up or preclude the use of atomic power, but also into such positive factors as the cost-reducing possibilities of relocation and process change just mentioned. The past experience of our industrial economy should not lead us to underestimate its potentiality for growth and change.

Economic Development

JUST where important impulses to economic development at home and in other countries may be felt as a result of atomic power is difficult to foresee. There may be, for example, major possibilities in the effects which the innovation will have on individual industries. Unusual cost reductions in one industry may set the stage for rapid growth in that industry and other related industries. There is the possibility, too, that process changes brought on by atomic power may give rise to new industrial activities designed to meet the needs for novel types of industrial equipment, new and untried engineering skills, and so on. Undoubtedly, the full impact of atomic power will not be experienced until these new industrial activities emerge and provide the processes, factories, and machines which can fulfil the inherent possibilities of low-cost atomic power.

Our industry analyses provide some indication of the possible importance of these effects. Process change, in particular, emerges as an important possibility in many of the industries we considered; it therefore seems reasonable to believe that atomic power will provide a fertile field for the development of new types of industrial activities which might contribute significantly to continued economic progress in the United States and elsewhere.

ATOMIC power might bring into play at least two distinctly new factors which are potentially of great importance to world economic development. Both of these are regional in character, and our evaluation of both depends on an analysis by industries. The first is the development of new production centers in some industries, which appears possible on the basis of our studies. If such new locations developed, the economic effect would often extend beyond the specific industry concerned, particularly if the region involved were one in which human resources had been under-utilized in the past. The initial impulse provided by the establishment of industry in such regions might set in motion a chain reaction leading to higher per-capita income in the area primarily as a result of the more effective utilization of local labor. In this case the increased mobility of the fuel resource might serve, in effect, as a partial substitute for the lack of mobility of the workers in the region who have remained despite the scarcity of employment opportunities. A study of the possible importance of such instances would be a fruitful field for further investigations about the economic impact of atomic power.

There are many countries throughout the world, such as Brazil, Argentina, Italy, and, perhaps, Great Britain, in which indigenous energy resources are so severely limited as to constitute a serious impediment to future economic development. Atomic power may be important to such countries for two reasons:

1. They may have abundant primary resources for atomic fuel which could take care of their future energy needs, e.g., Brazil has sizable deposits of thorium.

2. Even if they do not have such resources, they will probably be able to buy them (thorium or uranium ores and concentrates) at only a slight outlay of foreign exchange compared to the cost of its fuel equivalent in coal or petroleum — provided political and military considerations do not hinder such purchases.

As we pointed out earlier, the fuel component of the cost of atomic power is negligible. Capital charges are the important element in costs, and it is possible that either in the near future, as in Great Britain, or eventually, as in economically underdeveloped countries, much of the plant and equipment would be supplied from internal resources. In effect, this would remove fuel from that class of products which cannot under any circumstances be produced in adquate amounts from domestic resources. It is difficult to know how important this change would be without knowing the future prospects for world trade. But there are some grounds at least for believing that the physical and economic factors (i.e., foreign exchange difficulties) which might otherwise result in an extremely uneven distribution of energy supplies among the nations of the world could be greatly modified by the advent of commercial atomic power.

Where Do We Go From Here?

(Continued from Page 294)

velop to the utmost our greatest weapon of all, that working faith in the spirit of men that we call democracy.

Navigating our way through all the difficulties will certainly not be easy. But there are no supermen who, behind locked doors, are able to answer all our questions for us. Here again, as in the past, we must depend upon the proven capacity of the American people, talking these things over, to help pound out a sensible and a practical course, a course consistent with our democratic and humane traditions.

This we can do, as a people, I profoundly believe, but only if the country has in its hands the essential facts, right from the shoulder and without any "Papa-knows-best" nonsense. Only in this way, out of public debate can we reach that Great Consensus that has been our salvation in other periods of great difficulty.

In my opinion, the President's statement to the country concerning Russian progress was a shining demonstration of the best in American democracy, and the best in the American temperament. He didn't keep the news from the people, on the ground that it was an important piece of military intelligence, which it most certainly was. The President showed, in his brief statement that he does not share the view that atomic secrecy requires the abandonment of the very fundamental of democracy: the need of the people to essential information by which they may steer their own course. . . .

The American people, by and large, have by now pretty well chucked overboard the illusion that our atomic weapon stockpile is the single and complete answer to all of America's problems of security, the single and complete answer to Russian aggressive designs, and to the spread of Communist doctrine. This Myth fostered the notion that our economic and military aid to Europe was an unnecessary extravagance because we had what was called "The Secret" of the atom bomb, as if what we had was a mysterious formula that could be locked up in a vault. The Voice of America, the Point Four program for underdeveloped countries, our constructive efforts in the Middle East—all the vast complex of efforts we are making to help people help themselves and thus strengthen the foundations of freedom—the Myth declared that all this is unnecessary because we have this powerful weapon.

Now it is an error—a very great error indeed—to consider the atomic bomb as "just another weapon." For this ignores the profound way in which it has changed many of our concepts of getting along together in the world. It is, I believe, a fact that our possession of a great lead in this weapon provides —and if that lead is maintained may continue for some time to provide—a deterrent to armed aggression.

These things are true. But they do not justify the mischievous notion that the A-bomb is a simple and quick and cheap solution of our problems. Nor do they answer the questions thoughtful people are now asking—the kind of questions I referred to in the opening of these remarks.

We are coming to see more clearly that in the fierce contest to maintain a free and an open world the true strength of our cause today—as in ages past—lies in seeking a better and more prosperous life for men everywhere, in keeping alive and vigorous and healthy, the world over, the spirit of free and independent men.

We are coming to learn—the hard way—that, as Anne O'Hare McCormick has put it[2] "a solved problem only puts us in a little better position to attack the next one, that responsibility has no limits and no end."

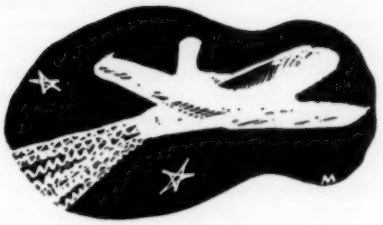
[2] *New York Times*, "The First Decade Is Not the Hardest," August 31, 1949.

Booklet on How To Do Business with AEC Now Available

A new booklet telling how to do business with the U.S. Atomic Energy Commission is now available from the Superintendent of Documents, Government Printing Office, at a price of ten cents. It has been prepared to assist businesses interested in selling products used in the national energy program, and is designed particularly for the guidance of small business concerns.

The booklet answers the questions: What is bought for the AEC? Who buys it? Where are the procurement offices located? It contains lists of the supplies, materials, and equipment being purchased by or for the AEC and its contractors, the addresses of the purchasing offices and agents, and instructions on how a business firm may be considered to receive invitations to bid.

ATOMIC POWER FOR AIRCRAFT



Lawrence R. Hafstad

Director of Reactor Development
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REACTOR projects have much in common with aircraft development projects. Both are expensive and risky. In both fields, one must obey the precept "Be bold, be bold and ever more be bold, but be not too bold." Following that advice takes more than technical knowledge. It requires wisdom.

Let us see what we are trying to do in the over-all atomic energy effort?

First: To maintain undisputed leadership in technical knowledge and facilities for the United States in all areas of the atomic energy field, either for war or for peace.

Second: To establish a trained corps of personnel familiar with all areas of atomic research and in particular with nuclear radiation and its hazards.

Third: To establish organized task forces sufficiently competent to explore, and sufficiently alert to exploit, any technical advance, which has promise for either peace or war.

Fourth: To see that the effort expended in the above activities is somehow kept proportional to the probable returns.

Reactors are the machines for giving us the controlled release of nuclear energy and, as such, certainly have promise both for peace and for war. Though the spectacular aspects of nuclear energy have been oversold in the popular press, the stubborn fact remains that one pound of uranium can be persuaded to release an amount of energy equivalent to two billion pounds of coal. When all is said and done, atomic energy is certainly not the magic perpetual motion machine which has been publicized, but it has the inherent possibilities of providing an incredibly compact storage battery.

Let's look at this analogy a little closer. Our ordinary automobile battery delivers 6 volts and has a capacity of about 100 ampere hours, or a total power storage therefore of, very roughly, one horsepower hour. A weight of uranium equal to that of an automobile battery would be capable of delivering about 300,000,000 horsepower hours. Edison was a great inventor, but the famous Edison cell, produced after years of effort, brought forth an improvement of only 30 per cent over the conventional lead cell, compared to a conceivable 300,000,000 per cent for the uranium energy source. The Forty-Niners had much less incentive than we have today.

So long as concentrated energy sources are desirable, fissionable material will be an "economic good." A stockpile of fissionable material would certainly be more useful than the gold at Fort Knox. In war, it could be used for bombs and might be used for propulsive power. In peace, it would be available for civilian power insofar as the supply, and the economics of the situation would permit. Accepting this, then considerable effort would appear to be justified on a special type of reactor called a "breeder," which shows promise of helping to maintain, and perhaps to augment, our supply of fissionable material.

To describe a breeder we must digress for just a moment to a technical detail. The element uranium, as it occurs in nature, is composed of two kinds. The fissionable variety from which we can get energy has a mass of 235 units. The other, unfissionable, has a mass of 238 units. The U-238 form is 139 times as prevalent as the U-235 form. The trick in a "breeder" type of reactor is this: With a proper choice and arrangement of materials, the neutrons which are produced in the initial natural U-235 fission processes can be captured—*after* they have released their energy—by the atoms of unfissionable U-238 and as a *by-product* used to convert the U-238 into a fissionable form of material. Thus it is conceivable, not only that energy can be extracted from U-235, but that as a by-product we may acquire a potential stockpile of fissionable material 139 times as great as we had when we started! With such a stockpile we might have a chance for diversions to power for civilian uses. Again we have a challenging goal and unless we have lost our zest for adventure, it is a goal from which we will be deterred only by a convincing demonstration of its scientific impossibility.

If reactors are so desirable, why don't we go ahead and build some? Now we come to the difficulties! Here are a few of them:

1. That for any reasonable thermodynamic efficiency in utilizing the great energies available, it is necessary to operate at temperatures well above the conventional engineering range.

2. The compactness of reactors, which is an important inherent advantage, proves troublesome in regard to the heat transfer problems which involve heat transfer rates far transcending previous experience.

3. The materials chosen for the reactor must withstand not only high temperatures but also high nuclear radiation densities, with unpredictable changes in the physical properties of the materials concerned. The seriousness of this problem can perhaps be visualized by this kind of comparison. How would you like to design airplanes or engines if, in use, the properties of the aluminum and steel would gradually change to those of cast iron or lead?

4. If we finally find a structural material for reactors which appears suitable so far as physical properties are concerned, we must now add still another requirement. The nuclear properties must be such that the structural material will not capture neutrons and thus deplete the supply and reduce the power. This requirement drives us to consider strange new elements and raises a whole array of procurement problems.

5. Even after we have our reactor working we find that the fission products produced as an essential part of the reaction "poison" the reaction itself. The ashes smother the fire. You are well aware of the enormous maintenance problems for aircraft engines. Every 800 hours they must be disassembled, inspected, have defective

[1] Based on a speech given before the Institute of Aeronautical Sciences, Los Angeles, California, on July 22.

parts replaced, and then re-assembled and tested. The work is staggering. However, how would you like it if, instead of being merely disassembled, the entire engine had to be dissolved in nitric acid, and the rebuilding of the engine started with getting a solution of certified chemically pure iron? This is the fuel reprocessing problem!

6. Finally, assuming we have solved the structural problems listed above, we have a whole new category of problems in connection with the working fluid or heat transfer medium used to convert the heat into power. The nature of these problems can be suggested by the fact that from rough comparisons of the volumes of reactors and the present highly perfected aircraft engines, the rates of heat transfer must be more than an order of magnitude greater for nuclear reactors than for conventional engines. Orthodox advances will not be sufficient. The problems involve the use of liquid metals with all the associated corrosion, erosion, purification and pumping troubles.

When one considers the host of difficulties and troubles which lie in the road ahead in the development of atomic power, the problem does look formidable. I am reminded of a statement made a little over a hundred years ago by the great chemist, Wöhler, in regard to the status of organic chemistry at that time. Wöhler wrote to Berzelius as follows:

"Organic chemistry just now is enough to drive one mad. It gives me the impression of a primeval tropical forest, full of the most remarkable things, a monstrous and boundless thicket, with no way of escape, into which one may well dread to enter."

That's an excellent description of the atomic energy field in 1949! In the meantime, however, what has happened to organic chemistry? Well, newspaper headlines give the answer. Miracle drugs are practically tailor-made these days. DDT and 2-4-D are taken for granted by the farmer. Synthetic rubber threatens to displace the natural product. A hundred years from now what will be the status of atomic energy? Who now has the wisdom to predict either failure or success?

The technical problems would be least in the land-based power reactor, and progressively more difficult in the ship and aircraft reactors; but the present priorities are just the other way around. Perhaps fortunately, however, the same ground must be covered in the initial stages whether the ultimate purpose is for civilian or military use.

I don't need to stress the importance of the incentive given to technical developments by military needs. We are painfully aware of the vicissitudes in the development of the airplane to the highly perfected state in which we have it today. Similarly in the atomic power field it appears that military needs will have to provide the incentive to carry through difficulties, even though ultimate dividends may be expected in the civilian economy.

Only if both the opportunities and the difficulties in the field of atomic energy are fully appreciated can the history of the atomic developments over the last several years be understood. This is a field in which the experts disagree. The more distinguished they are, the more violently they disagree. When experts disagree, a middle-of-the-road course of action is indicated, and this indeed is what we have in the Commission's Reactor Development Program.

The nation has had reactors of various kinds, from almost the beginning of its atomic energy program. The next phase calls for designing and constructing reactors which are larger, more complicated, and more difficult to build than any we have produced thus far. As in any new technical development, there are many uncertainties and many risks involved. It is here that the experts disagree on details of designs of reactors which will do the jobs that need to be done. Largely for this reason, in the four years since the end of the war, no really new or greatly improved versions of reactors have been built in this country. The reactor of most advanced design and performance is in Canada.

The proposed reactor development program of the Commission crystallized out of the four years of discussion and argument as well as from new knowledge gained from the applied research program since the end of the war. Reactors can conceivably be used for a wide variety of purposes. Special reactors of many types have been proposed by responsible people for purposes varying from small compact units for propelling guided missiles, to huge stationary power plants for providing cheap electric power for our great cities and distilling ocean water for irrigating our deserts. To the people most fully informed, it is clear that the difficulties of building any reactor are so great that only a very few projects can be adequately supported with money and particularly with competent technical manpower at the present time. For this reason it is essential that from the multitude of possible reactors only a few carefully selected projects should be chosen, and very strong technical support should be focused on these few.

An obvious forward step would be the design of a reactor in which the neutrons produce fissionable materials as in the existing production reactors but, in addition, the heat generated is put to work. Unfortunately, scientists and engineers at present do not have enough basic knowledge to design such obviously desirable reactors. Their first step would appear to be to produce a reactor specifically for the single purpose of generating large amounts of heat at a temperature which will permit conversion to power. So extensive is our ignorance, however, that even such a simplified design is forcing us into pioneering activities beyond the present boundaries of human knowledge. Before any reactor can be built with a performance appreciably better than those we now have, a large amount of applied research in very specialized fields is necessary. This is the activity with which our laboratories have been preoccupied for the last four years.

We are now at the stage where, if we intend to progress further, it will be necessary to find the courage to build a few reactors to test what we think we know. The reactors in the Commission's program are essentially experimental prototypes. None of them can be described as an "end-item" which will drive an airplane or a ship, or power and light a city. Further generations of reactors will be required before such desirable goals can be attained. It is this fact which sets a time scale of ten to twenty years before useful and economical civilian applications of atomic power can be expected. However, if the ultimate goal is ever to be attained, the first steps must sooner or later be taken, and it is these first steps with which we are concerned in the present reactor program.

As described by Dr. Robert F. Bacher, former commissioner, and a moving force in reactor development work, the current program consists of four reactors.

1. The first of these has been designated as a materials testing reactor. We call it "MTR." This reactor is of particular interest to the Air Force

since it represents the boldest step into the unknown which we now dare to take, moving in the direction of compact, high radiation density reactors which must ultimately be developed if the Air Force needs are to be satisfied.

2. The second reactor is a land-based prototype of a reactor for use in propelling naval vessels. It would be a simple, single purpose reactor designed specifically and solely for the purpose of producing large amounts of heat, under conditions which will permit conversion to propulsive power.

3. The third reactor is a single purpose experimental reactor designed specifically to give us information about the breeding process.

4. The fourth reactor is the more ambitious project—the Knolls Atomic Power Laboratory Reactor. This reactor is intended to produce a really significant amount of electric power. At the same time, it is hoped that this reactor will be able to demonstrate at least partial success in breeding. This reactor is, therefore, a very complex device, since its design represents a compromise between the demands for power production and for breeding. If successful, however, this reactor would represent a major step forward in the direction of the production of useful power without depleting, and perhaps even increasing, our national supply of fissionable material for any purpose.

Whether by accident or by design, this program is a reasonable middle-of-the-road program. It represents a balance between reactors contributing to the solution of military and civilian problems; a balance between reactors which use up fissionable material and reactors which promise to replenish or increase our national supply of fissionable material; a balance between a bold attempt to solve immediate problems by the engineering approach, as in the Navy reactor and the intermediate breeder, and the more long-term research approach of gaining information about the behavior of materials under novel, but controllable conditions, as in the materials testing reactor and the experimental fast neutron breeder.

I would like now to comment on the fourth requirement which I mentioned above and which was concerned with getting value received for money invested. How does one put a money value on any new developments, particularly on one of a military nature? What, for example, would have been the value of the "Merrimac" to the South had not the "Monitor" come along? What was the value of the "Monitor" to the North in 1862 dollars? If we want to be modern, what was the value of the "Spitfire" in the Battle of Britain, or what is the current value of an atomic bomb?

We have heard much discussion recently of the cost of producing atom bombs, but what are they really worth to us—in dollars? It would be helpful to have at least a rough estimate of the present value of an A-bomb, either in dollars or in equivalent divisions or battleships or air-groups. While this may sound difficult, order of magnitude engineering estimates, to keep our thinking straight, are not too hard to make.

We know, for example, that at the end of the war our daily war expenses were approaching $300 million per day. If the A-bombs shortened the war by even 10 days, the entire $2,500,000,000 cost of the Manhattan effort can be written off, and recorded, as a spectacular success, and a *value*, as contrasted to *cost*, of at least $1,500,000,000 each be set on the Hiroshima and Nagasaki bombs.

Since warfare seems to be mainly a competitive destruction, we can get another estimate in an entirely different way. Taking the radius of destruction for a bomb as from one to two miles, the area destroyed would be approximately six square miles. In an average city the property value runs perhaps $50,000,000 per square mile. The destruction per bomb, therefore, represents about $300,000,0000 and gives a figure of the "advantage" to us, and therefore of the value to us, in this insane competition in destructiveness.

Finally, let us approach the problem in still another way, using an infantile form of operations research. We have been told that one A-bomb is equivalent in effect to 20,000 tons of TNT. Since big, single bursts "overkill" at the center, let us cut this by some suitable factor, say 10, for example. Now one of our large bombers can carry a pay load of about ten tons; therefore, to carry 2,000 tons would require 200 planes. This is unassailably accurate arithmetic! Large bombers cost half-a-million dollars to build, but with logistic support, more like $2, 000,000 in combat. One A-bomb makes one bomber the equivalent of two hundred. Ergo, one bomb is "worth" $400,000,000.

There is another conclusion which can be drawn from this quick operations research calculation. We should think twice or maybe even three times before permitting too casual diversions of material from the stockpile, even for other conceivable military uses. It follows also that civilian power will remain "pie in the sky" unless, by a "break" in the breeder program or some other solution to the raw material problem, a more ample supply of fissionable material can be provided. Finally, it follows that this is indeed a game in which, if we are to play at all, we play with "blue chips."

In the reactor field what would the nuclear-powered air equivalent of the "Merrimac" be worth in a future contest against a fleet of chemically-fueled airplanes? What would a nuclear-powered naval vessel be worth in a future engagement if it were—as the "Merrimac" and "Monitor" were—one whole generation ahead of the conventional fleets of the day? What would be the value to the nation if, as has been suggested, atomic energy could be used to evaporate sea water to make the deserts bloom? These are the really fundamental questions, and I am glad that it is Congress' responsibility and not mine to make decisions on them. It is, however, my responsibility to see that we get value received out of each dollar which is appropriated for the reactor program, and this will require, more than anything else, that effort be kept commensurate with both priority and promise.

I would like to return to the aircraft propulsion reactor to consider it more in detail. In the Brewster Report we find the following statement:

"In the event of war or in any international situation likely to lead to war, nuclear energy for the propulsion of aircraft would be comparable in significance to the atomic bomb itself. Presently known limitations inherent in all chemical fuels make difficult the delivery by air of atomic bombs against a distant enemy. Therefore, if the United States had nuclear energy propulsion in addition to atomic bombs, it would be the dominant factor in maintaining world peace."

With the desirability of an ideal solution to this problem there is general agreement. There is agreement, too, in regard to the contention that

developing any kind of an aircraft reactor will be extremely difficult. The NEPA Project, carried out by the Fairchild Company, under an Air Force contract, has been engaged in a vigorous attack on this problem since 1945. The North American Aviation Company and the Rand Project have also made important contributions. These studies all seem to indicate that, granting the difficulties of the reactor problem itself, the power conversion problem represents a challenge of almost equal magnitude.

As seems to be characteristic of this field of activity, anything which is obviously desirable and important seems to be almost incredibly difficult. To help resolve the impasse, the Commission last year made a contract with the Massachusetts Institute of Technology to make a study of the problem and to come up with recommendations. The result of this study was the Lexington Report, the details of which are at present quite properly highly classified.

The immediate course of action indicated in the Lexington Report is essentially that the aircraft propulsion project should be continued in an intensive study phase, both theoretical and experimental, for the next two or three years, by which time it might be hoped that data might become available to permit a re-evaluation and a more decisive conclusion. It is recognized that this study phase should be made national in scope to include the NACA and AEC as well as the National Military Establishment.

These are eminently sound guideposts, and they are being followed. An *ad hoc* committee, consisting of representatives of the Air Force, Bureau of Aeronautics, NACA, and AEC, has been meeting since last January to coordinate the work of the various government agencies involved and to insure an industry-wide approach to the technical problems. In such a joint attack on a problem, clearly there will be some duplication which must be eliminated and some shifts of emphasis which somehow be consummated. Committee procedures grind slowly, but this work is well underway.

In the meantime, in accordance with the Lexington Project recommendations, the NME has been asked to evaluate the military worth of the proposed weapon if and when it is produced. This is a really tough assignment. It is indeed controversial, but not in the sense of an inter-service feud. This is definitely not an Air Force *vs.* Navy issue. Both the Air Force and the Bureau of Aeronautics want nuclear-powered airplanes if at all possible, and, so long as the Atomic Energy Act is in existence, neither can hope to build a private empire in this field even if it so desired. The issue, and the controversy, is really a fundamental one. It rests on the typical, perplexing, circular, hen-and-the-egg nature of all the decisions involving new weapons which the military are continuously asked to make. How valuable nuclear-powered aircraft might be depends heavily upon when it will be available, what the maintenance problems are, what the cost will be in diversion of fissionable material, not only for the aircraft reactors installed, but also for the inventory required by the complex reprocessing procedures required for nuclear fuels. Unfortunately, the answers to these questions depend on the priority which is attached to the development program. How soon nuclear-powered aircraft can be available depends on how much effort we put into the program. Similarly, how soon we can give information as to probable performance and costs will depend on how rapidly the work progresses. The dilemma is very real and very serious. It was to aid in solving just such problems that the Weapons Systems Evaluation Group, under General Hull, was set up in the National Military Establishment.

The best summary of the situation which I can give is that the pessimists, who in general are those best informed, have thought through the immediate reactor and power-transfer problems and are staggered by the maintenance and operations problems which would be involved if the actual aircraft propulsion devices for combat use were to be based on our present knowledge and practices. The optimists, on the other hand, either are not yet aware of the very real immediate difficulties or they are betting heavily on new ideas and new developments arising during the course of the work which avoid some of the currently foreseeable troubles. In this connection, I seem to recall, however, that not many years ago all the technical facts, and all the arguments of the experts, indicated an upper limit of 100,000 pounds as an absolute ceiling for the size of heavier-than-air-craft. This is an area in which it will no doubt be wise for us to be open-minded but skeptical. The best we can hope for in a program such as this is one in which the best available advice is sought and used.

Scientists Objecting to War Work Organize

A NEW organization, the Society for Social Responsibility in Science, was formed in mid-September by a group of scientists and engineers from several states meeting at Haverford College, Pennsylvania.

The aim of the society, as announced in its constitution is:

"to foster throughout the world a tradition of personal moral responsibility for the consequences for humanity of professional activity, with emphasis on constructive alternatives to militarism; to embody in this tradition the principle that the individual must abstain from destructive work and devote himself to constructive work, according to his own moral judgment; to ascertain the boundary between constructive and destructive work, to serve as a guide for individual and group decisions and action; to establish and operate an employment service for those individuals whose convictions necessitate leaving or refusing destructive work; to assist those individuals who suffer economic or legal difficulties because of abstaining from destructive activity."

English, German, and Swiss scientists have expressed interest in joining the SSRS.

The President of the new society, Victor Paschkis, said that scientists have "usually omitted all the social and moral aspects of their work in their decisions as to what problems to tackle." The new society's members are exceptions to this tendency, Dr. Paschkis said, and trace their heterodoxy back at least as far as Leonardo da Vinci's invention of a submarine which he refused to describe publicly "lest man put it to evil purposes." A present-day example is Professor Norbert Wiener, who recently refused to put his knowledge at the disposal of the armed forces of his country.[1]

The officers of the new society are: President, Victor Paschkis, of Neshanic Station, N.J., director of an engineering research laboratory of Columbia University; Vice-President, William F. Hewitt, Jr., of Washington, D.C., physiologist at Howard University School of Medicine; and Secretary-Treasurer, Vincent Cochrane of Middletown, Connecticut, biologist at Wesleyan University.

[1] See Norbert Wiener, "A Scientist Rebels," *Bulletin*, III (January 1, 1947) and "A Rebellious Scientist after Two Years," *Ibid*, IV (November, 1948).

CONSERVATION OF WORLD RESOURCES
A REPORT ON U.N. SCIENTIFIC CONFERENCE

Francis W. Carpenter

Associated Press
Lake Success, N.Y.

IF NEW methods of science are put to work, there is no need to fear that the world's essential raw materials will be exhausted and that the demands of the ever-increasing population of the world cannot be met.

That was the opinion of many of the 640 scientists and experts from fifty countries who were present at the United Nations Scientific Conference on the Conservation and Utilization of Resources at Lake Success from 17 August through 6 September, 1949.

Every section of the world was represented at the scientific talking-bee except the Soviet Union. Even representatives from some of the Eastern European states within the Soviet sphere of influence were present—but the Russians held aloof.

One important member of the conference said privately he believed the Soviet Union had missed a good bet by refusing to attend. He said their people would not have lost a thing at the meeting — and they would have learned plenty.

The conference was the first world conservation conference of its kind ever to be held. There were some leading conservationists, such as Mrs. Gifford Pinchot, widow of the former governor of Pennsylvania and a life-long conservationist, who felt the conference should have taken action. She demanded in one general meeting to know why its hands had been tied; why the conference could not pass resolutions.

The answer was that it just was not that kind of a conference. The United Nations Economic and Social Council, which has been doing a lot of unheralded good work in the midst of political tensions, set up the meeting. The members of the conference came as individuals and not as representatives of their governments. It was one of the cheapest meetings the U.N. ever held, for most of the members paid their own expenses and the sessions were held in the sprawling U.N. headquarters, where the delegates had every facility for quiet talks.

The Economic and Social Council specifically directed in its orders for the conference that no resolutions be passed and that no action be taken binding the governments. So the scientists and experts had a free and easy time discussing their pet subjects without worrying about political repercussions.

The conference actually was the first step by the United Nations toward mobilizing the science of the whole world to promote higher standards of living.

One of the best methods of doing this is through the conservation and wise utilization of natural resources. The conference provided a forum for the exchange of ideas and experiences. This was done in great detail. The conference was divided into sections: Land, Water, Forest, Wildlife and Fish, Fuels and Energy, Minerals.

Papers were submitted on almost every conceivable subject. The proceedings will be published so that persons interested may obtain the papers and the discussions.

The United Nations described the main topics on which papers were read and discussions took place in the general meetings of the conference as follows:

"The world resource situation (the legacy of resource depletion, the increasing pressure of resources); a world review of critical shortages (food, forests, minerals, fuels); the inter-dependence of resources (the complementary nature of European resources, the planning of land use for full production, with special reference to European conditions); the use and conservation of resources (soil and forest conservation and the protection of water supplies, techniques for increasing agricultural production, estimates of undiscovered oil and gas reserves, economics of competitive fuels for various purposes and their use to meet future fuel requirements, metals in relation to living standards); the development of new resources by applied technology (fodder yeast and algae, the contribution of chemurgy, wood fiber, food yeast, fat synthesis by micro-organisms and its possible applications in food industry); methods of resource appraisal; the adaption of resource programs; assessing resources in relation to industrialization plans; education for conservation; resource techniques for less developed countries; and the integrated development of river basins."

There was one heated argument in the conference on estimates of coal and oil resources. One expert said there was enough to last for many years; others saw alarm in the depletion of coal and oil supplies. The conference finally decided that no one knew how much coal and oil are under ground, which several of the conference members took to be a sensible opinion for the conference to hold.

In the words of praise and congratulation at the end of the conference there came something of a knock for the scientists. Mrs. Vijayalakshmi Pandit, Ambassador of India to the United States, spoke at the final plenary session. In effect, she said that scientists had raised many spectres to haunt man —meaning, obviously, the atomic bomb among other things—and that therefore scientists must once again lead the crusade against fear of want, of insecurity, and of death.

"Now that the heart of man is frozen with fear—fear of want, of death—science must once again lead the crusade, not only because it has the means, but, because many of the spectres which haunt us today have unfortunately emanated from its own creations," she told the conference.

James Thorne, of New Zealand, President of the Economic and Social Council, said that the discussions, the constant exchange of views, and the technical papers presented were "a working blueprint" for United Nations plans for technical aid to underdeveloped areas. Thorne warned against the evils of cyclic swings from "boom to bust." He said that during periods of prosperity

farmers tended to forget the needs of the soil. Then, when depression set in, they were unable to undo past mistakes.

Finally, he said, science was offering man new horizons, to refute "the gloomy forebodings" that man is unable to feed himself. "A new era of peace and prosperity awaits mankind if modern techniques and science are applied to resources."

J. A. Krug, United States Secretary of the Interior, who played a prominent role in the conference meetings, said the conference had demonstrated at least three important points:

1. Interest in conservation and development of resources was confined neither geographically nor to specific resources;

2. The scientists and experts of the world had demonstrated here that it was possible to overcome differences in language and cultural background to reach a better understanding about what needed to be done to assure a decent standard of living for the people of the world;

3. The "bold new program" that President Truman was advancing for the development of the underdeveloped areas of the world had vast support not only in those areas but in the world generally.

One of the happiest persons at the success of the conference was Trygve Lie, United Nations Secretary-General. Usually he is beset by heavy political problems and by the constant disagreement between East and West. He is sometimes discouraged but he never quits and he was obviously pleased about this scientific gathering. Addressing the closing session on September 6, he said:

"I think that one of the most important results of this conference has been to demonstrate to the peoples of the world that the United Nations is concerned with building the economic and technological foundations of international peace by enlisting the collaboration of the scientists and the technical world."

Lie said that he was confident that "as progress towards a stable peace continues, an increasing proportion of our work here at the United Nations will be devoted to constructive efforts for the economic development of the world and the raising of the living standards of its peoples."

In this task, Lie said, "we shall rely to a very large extent on scientists and technicians for their help and advice, as individuals or small groups collaborating on specific projects and in conferences of broader scope such as this one."

Military and Civil Confusion about Civil Defense

(Continued from Page 297)

reference to what weapons will do. Whoever tries to make civil defense plans needs such information, and the military responsibility is to provide it. The Military Establishment should at least do the best it can by furnishing general information about weapons if it cannot be specific.

There are some examples of what could be provided. The book *Fire and the Air War*, published by the National Fire Protection Association in 1946, interpreted the lessons of the use of incendiaries and high explosives. The book *Must We Hide?* by Dr. R. E. Lapp recently explained considerations in attacks on U. S. cities by atomic bombs. Both of these texts contain the sort of information needed for civil defense planning. If such statements can be produced by a few individuals, it ought to be possible for the Department of Defense to formulate something similar which would be official and which would represent the best military judgment.

Lieutenant General Leslie B. Groves, now Vice President of the Remington Rand Corporation, speaking before the New Jersey State Association of Police Chiefs on June 30, gave that body a forthright personal estimate of what kind of situation they might expect from atomic bomb attacks. General Groves' talk to the New Jersey police chiefs demonstrates that competent military opinions can be formulated. In my opinion it would have been more to the point if General Groves' statement had been formulated and issued when his official connection was with the Department of Defense.

My feeling is that the Hopley Report should have taken the form of a statement of typical expected situations. If the military position could not be definitely stated, it would have been quite in order for the Department of Defense to candidly state the difficulties, but give as much information as possible. There is a good example of what can be done in a publication of the National Security Resources Board, *National Security Factors in Industrial Location.* This statement is offered, not as a plan, but to provide information so that appropriate decisions on plant location can be made by industrial management in line with considerations of the national defense.

PLANNING BY CIVILIANS

THERE has been a good deal of confusion about civil defense planning. The military felt it had to produce a plan and is disturbed to find its efforts coldly received. On the other hand, state and city authorities have sat back waiting for a plan. Delegates to the convention of the American Municipal Association came to Washington last winter with the idea they were going to get a plan. They changed their minds when they came up against the problem. I interpret their reaction as a feeling that the details of plans should be made by civil, not military authorities.

The realistic division of work is for the military authorities to define the problem and for the civil authorities to make the plans for civil action.

PLANNING BY MILITARY

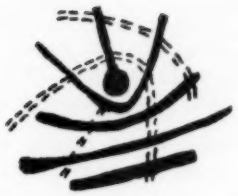
THE fact is that both the military and civil authorities have a job to do in civil defense. Both should get on with it, each making the contributions it is best qualified to make.

I can think of a number of civil defense activities which should be continued by the Department of Defense. For example, there are numerous important research jobs which should go ahead regardless of final determinations on national civil defense organization. I understand that a program of civil defense research has been outlined in a report on research and development which was prepared by Dr. Kenneth L. Heaton, expert consultant to the Secretary of Defense. Arrangements to get such a program under way at once are of real urgency.

Two other activities for the Department of Defense to continue should be mentioned. One is to publish as much weapon data applicable to civil defense as possible. The other is to hold joint military and civil exercises in civil defense. This would help both military and civil authorities to understand their respective roles.

"ATOMIC ENERGY AND THE LIFE SCIENCES"

AEC SIXTH SEMIANNUAL REPORT



Summarized by George V. LeRoy, M.D.

Following BULLETIN practice, we present a synopsis of the current half-yearly report of the Atomic Energy Commission. The reviewer is Director of the Radioisotope Unit at the Veterans Administration Hospital at Hines, Illinois. During the war Dr. LeRoy was a member of the Joint Commission for the Investigation of the Effects of the Atomic Bomb in Japan.

THE military application of atomic energy, and its repercussion on political thinking, has been the most spectacular result of contemporary research in nuclear physics up to the present time. Most people are aware of the fact that some significant advances are also being made in the biologic sciences through the application of the principles and products of nuclear research. The early security regulations, and the highly technical character of much of the work has prevented a general appreciation of the scope of these studies. The Sixth Semiannual Report[1] of the Atomic Energy Commission is almost entirely devoted to a detailed and readable description of the research in biology and medicine which is supported by the AEC. In a Foreword to this portion of the Report Dr. Alan Gregg, Chairman of the AEC Advisory Committee on Biology and Medicine; and Director for Medical Sciences, Rockefeller Foundation, expounds the viewpoint of the AEC's Division of Biology and Medicine.

"The story of the Garden of Eden and the myth of the Promethean fire find uncanny parallels in the huge responsibilities of the Atomic Energy Commission to control the unprecedented forces of atomic energy for the welfare of man. To control the use of this power, to explore its nature, its implications and potential applications, and at the same time to protect us all against its dangers—these responsibilities set a series of tasks that also are without precedent and all but immeasurable.

"The Commission is charged by law with the exclusive control of materials, equipment, and processes which are unique, constantly dangerous, and certainly not yet sufficiently understood. To this task is added the difficult circumstance, foreign to most other scientific enterprise, of secrecy. Therefore, the Commission has every reason to assume extensive responsibilities for the further development and study of atomic energy and its products and their effects on human beings, animals, and plants."

DEVELOPMENT OF THE PROGRAM

AFTER taking office in 1947, the Commission appointed a Medical Board of Review from a panel of scientists and educators nominated by the President of the National Academy of Sciences. In June, 1947, this board submitted a report which has had an important influence on the development of the Commission's program.

Specifically, the board recommended that the Commission:

a) Expand research on the biological effects of radiation on a nationwide scale—in its own installations and also in universities and other outside institutions whenever the nature of the work permitted.

b) Take primary responsibility for the protection of health against atomic energy hazards—conducting studies and training personnel in its own installations and making use of the assistance of outside institutions whenever feasible.

c) Continue to distribute isotopes at nominal prices for research in all the sciences; provide assistance in their safe utilization; and consider making them available to foreign investigators.

d) Actively encourage the circulation of scientific information, the declassification and publication of the scientific papers produced by the atomic energy project.

e) Work closely with the medical personnel of the Armed Forces and the United States Public Health Service to develop the knowledge, the techniques, and the trained personnel needed to protect Americans from the hazards of atomic energy in peace or war.

f) Institute a fellowship program to train promising students for careers in the field of the biological and medical effects of radiation; also, a technical training program in the techniques and skills of "health physics."

g) Aggressively survey the human resources of the nation for the task ahead; (1) the centers of teaching and other sources of recruitment of the great number of additional workers needed, and (2) the workers already in the field, who would necessarily be key figures in the expanding program.

h) Create a permanent Advisory Committee for Biology and Medicine, to recommend to the Commission a general policy of research and health; and finally,

i) Appoint within the Commission a medical director to assume general responsibility for the research and training programs in both biology and medicine and for health protection activities.

Every one of these recommendations has been turned into a going program during the two years since they were made.

Advisory Committee for Biology and Medicine

IN SEPTEMBER, 1947, the Commission appointed a permanent Advisory Committee for Biology and Medicine, of the following distinguished leaders in the field, all of whom are still serving at this time:

DR. ALAN GREGG, Director of Medical Sciences, Rockefeller Foundation, New York, N. Y., Chairman.

DR. ERNEST W. GOODPASTURE, Dean of the School of Medicine and Professor of Pathology, Vanderbilt University, Nashville, Tenn., Vice-Chairman.

DR. G. W. BEADLE, Chairman of Division of Biology, California Institute of Technology, Pasadena, Calif.

DR. DETLEV W. BRONK, President, Johns Hopkins University, Baltimore, Md., and Chairman, National Research Council.

1 Washington, D.C.: United States Government Printing Office, 1949. Price 45 cents.

DR. A. BAIRD HASTINGS, Professor of Biochemistry, Harvard Medical School, Boston, Mass.

DR. E. C. STAKMAN, Chief, Division of Plant Pathology and Botany, University of Minnesota, Minneapolis, Minn., and President, American Association for Advancement of Science.

DR. JOSEPH T. WEARN, Dean of the School of Medicine, Western Reserve University, Cleveland, Ohio

The Division of Biology and Medicine

ONE of the first services of the Committee was to assist the Commission in establishing in its Washington headquarters, a Division of Biology and Medicine and in recruiting the experienced staff required. This division is now organized in three branches:

The Biology Branch sponsors research on the effects of atomic energy on animal and plant life and also research conducted with atomic energy materials (radioactive and stable isotopes) into animal and plant physiology, particularly as they relate to the fields of agriculture and the treatment of animal and plant diseases.

The Medical Branch develops programs for safeguarding the health of employees and populations in and about AEC facilities; sponsors research on the mechanism, diagnosis, and treatment of radiation injuries and the use of radioisotopes in medicine; and supervises the Commission's cancer program and the work of the Atomic Casualty Commission in Japan.

The Biophysics Branch develops policies and standards for the detection and control of radiation and protection of personnel, control of contamination, disposal of radioactive material, and the training of personnel in all this work; sponsors research programs in biophysics.

The Director of the Division of Biology and Medicine, since its foundation, has been Dr. Shields Warren, Professor of Pathology, Harvard Medical School. Dr. Warren is an internationally recognised authority on the effects of radiation on human beings and other organisms. The great achievements of the AEC in the field of biology and medicine are due in a large part to the wise leadership of Dr. Warren.

In the Report, the work of the AEC is presented in three parts: (1) Radiation and Life; (2) Protection against Radiation; and (3) Benefits from Atomic Energy. We now consider, synoptically, the contents of each of these sections.

RADIATION AND LIFE

IONIZING radiation (α-particles, β-particles, gamma rays, X-rays and neutrons) affect all living things in basically the same way. All living organisms are composed of cells; and each cell contains a large number of molecules of varying size. The interrelations and the reactions of these cells and their constituents depends on the maintenance of a delicate electrical equilibrium resulting from the electrical charges that bind together the atoms of molecules, and the molecules themselves. In passing through living tissue radiation not only may destroy or alter these electrical balances and bonds, but it may also break the molecules into fragments carrying electrical charges. These fragments are "ions," and the types of radiation that produce them are called "ionizing radiations." The re-combination of these fragments—or ions—after the radiation has stopped is haphazard, and the new relations are usually deleterious to highly organized cells. Beyond these general facts, very little is known of the precise mechanism by which the harmful effects of radiation are exerted. Fundamental research supported by the AEC is directed toward a study of the changes which occur in the constitutents of individual cells; in single cells existing as units; and in multicellular organisms of every degree of complexity from the simplest slime moulds to the highest mammals.

All living organisms contain mechanisms, called enzyme systems capable of transferring the potential energy in food and oxygen into the forms of energy required to maintain the life of the organism. The effect of radiation on such systems is under investigation at the Argonne National Laboratory, the Oak Ridge National Laboratory, the Los Alamos Scientific Laboratory, and in many universities under contract with the AEC. In specialized regions of each cell there is a structure, the nucleus, which is concerned with the ability of the cell to reproduce itself, and which is the source of the chromosomes and their units, the genes. These latter entities are the agents of heredity, and in ways as yet unknown, accomplish the unique function assuring that each offspring of a cell will have the identical characteristics and potentialities of its parent. The cell nucleus contains typical materials: nucleoproteins and nucleic acids which are being studied in many laboratories. The group at the Radiation Laboratory, University of California, have found that ionizing radiation impairs the rate of formation of these substances. Individual cells are small—10 to 200 microns in diameter—no larger than the point of a pin. In spite of this, apparatus is being constructed at the University of Chicago which will permit the irradiation of selected regions of cells. When completed, the "microbeam irradiator" will help extend our knowledge of the site of action of radiation.

Tissues and organs may be considered as societies composed of groups of cells. Such tissues have greater capabilities than the sum of their components. Likewise, the response of tissues and organs to ionizing radiation differs quantitatively and qualitatively from the effects on single cells. In many laboratories, fragments of tissue and entire organs are cultivated, and the action of radiation is studied. At Argonne, radioactive sources in the shape of beads are planted in organs, and the pattern of injury and recovery is followed. The well-known variations in the blood after irradiation are being explored more thoroughly in dozens of institutions in the effort to extend and interpret the facts that are known.

As a corollary to these studies of the mode of action of radiation, research groups at Oak Ridge and at the University of Michigan are attempting to develop simple blood tests which can be applied on a large scale to individuals who may have been exposed to radiation. Such tests would be of inestimable value in the case of atomic warfare, or after accidents in atomic energy plants.

At Brookhaven National Laboratory and at other places our scanty knowledge of the mode of action of radiation is being applied to devise methods of developing resistance to the effects of radiation. The ultimate benefit from successful research of this sort is obvious.

ALL kinds of animals and plants that can be used for studying the mode of action of radiation are used in the laboratories of the AEC and its contractors. All these studies are directed to a considerable extent to the accumulation of knowledge which will permit the understanding and treatment of acute Radiation Illness—the new disease which was the fate of thousands of Japanese, and of a small number of American scientists. Studies initiated in Japan by the Medical Department of the Army, and the Bureau of Medicine of the Navy are being continued. The AEC has financed the Atomic Bomb Casualty Commission of the National Research Council. Members of this group work in Japan, with

Japanese scientific associates, and are conducting a long-term follow-up study of as many of the survivors of Hiroshima and Nagasaki as can be found. It is of great interest that to date the investigators have found no evidence of increased occurence of any disease, including cancer. The effects of the atomic bomb radiation on fertility and longevity are also being studied.

Radiation and Heredity

HIGH energy radiation, in addition to causing burns and radiation illness, affects living things in a more subtle way that cannot be detected so immediately or so readily. It changes the cellular material which governs heredity in people, animals, and plants, and thus alters the characteristics passed on from one generation to the next. Not all these effects are harmful. Some, such as certain changes in corn, for example, may in fact be used to improve the yield, food qualities, and disease resistance of hybrid varieties. But in an age when people are using many forms of powerful radiation in science, in medicine, in industry, in warfare, it is urgently important to learn everything possible about how radiation affects heredity.

The units of heredity in the germ cells of the animal body are the chromosomes, of which there are 48 in man. The functional components of the chromosomes are called "genes," of which there are believed to be 10,000 or more in each human germ cell. In a manner, still unknown, these genes regulate the characteristics of the organism in which they occur in such a way that offspring resemble the parents in an uncanny manner. Variable characteristics in man, such as eye color, hair color, size, etc., are transmitted by genes. Certain diseases, as hemophilia, sickle-cell anemia, night blindness, etc., also have a genic basis. The spontaneous occurrence of a change in the hereditary pattern or genic constitution of an organism is called a mutation. Such changes may be favorable or unfavorable to the individual and his family. The rate at which mutation naturally occurs in breeding is of the order of one time in a million. Favorable mutations are rare, perhaps 1 per cent of all mutations, but they are believed to be the basis of evolution in all living things. Unfavorable mutations may result in the death of the offspring, or they may result in a worsening of the species concerned, so that it is less fit for the struggle for existence.

In 1926, H. J. Muller, of Indiana University, discovered that the mutation rate in genes of the fruit fly could be greatly increased by X-irradiation. It is now known that ionizing radiations affect similarly all living things. The AEC devotes a major part of its biological research to a study of the effects of radiation on heredity. A roster of all the studies in progress would be too long for this review, but a few may be mentioned. A single-celled animalcule, Paramecium, is being studied at Argonne and Oak Ridge. Pink bread mould is under investigation at California Institute of Technology and at Oak Ridge. In many laboratories, the common spiderwort, Tradescantia, has been used for exploring the action of radiation on genetics. At Brookhaven, the trillium is used. Corn genetics is the basis of the vast and profitable hybrid corn industry in this country; and studies of radiation on corn have been made at Cal. Tech., Argonne, and other places. Corn seed irradiated during the Bikini tests are being cultivated and their mutations studied. The fruit fly—the chief subject of genetics research for many years—is used in dozens of laboratories. Fish genetic studies, using fish irradiated at Bikini, and in the laboratory, are supported by the AEC at the University of Washington. Extensive studies of mouse genetics and radiation are under way at Oak Ridge and at the University of Rochester. All of these studies have a common goal—the understanding of the genetic mechanism as it applies to all organisms including man, and the effects of various amounts of radiation on these mechanisms. All of us are exposed to a small amount of irradiation from cosmic rays throughout our lives. At sea level, cosmic irradiation amounts to 3 roentgens (the unit of measurement of ionizing radiation) per lifetime. The maximum permissible tolerance dose of radiation, as currently defined, is 0.3 roentgens per week—or about 400 roentgens in a 25-year working career. It is of the greatest importance to determine whether low-intensity radiation received over so many years, can alter the human mutation rate.

PROTECTION AGAINST RADIATION

THE Commission has an overriding responsibility to safeguard people against radiation that originates in atomic production or research. It must protect the health of scientists and workers in Commission and other installations, and of the people who live nearby. All the knowledge that scientists gain in their study of the effects of radiation helps the Commission to assure adequate protection.

Before the wartime experimentation with releasing atomic energy, only those scientists accustomed to work with X-ray, radium, and the few "atom smashers" that existed knew much about protection against radiation.

The first radiation injury—burns from an X-ray—was reported in 1896. It was not until 1915, after many X-ray injuries occurred in hospitals during the war, that the general problem was recognized. And it was 1929 before the National Committee on Radiation Protection, established in the United States, drew up standard methods of radiation protection which were published in a handbook by the National Bureau of Standards. This was the extent of general information in 1942 when, under the concrete West Stands of Stagg Field, University of Chicago stadium, scientists began construction of what was to be the first successful chain-reacting "atomic pile."

At that time, some experts doubted that such a nuclear reactor could be operated safely. Previously, scientists had worked with only small masses of radioactive material shielded with thick boxes of heavy lead. Yet people had died from overexposure to radium and to X-rays. Now it was proposed to operate nuclear reactors each of which would create more radiation than had existed in the entire world.

The fears of these experts proved groundless—not because they overestimated the danger, but because the responsible officials of the Manhattan District recognized the perils involved and called in specialists in radiology and biophysics to apply the knowledge of the past and make sure that the shielding that was built was completely adequate to stop and absorb radiation.

Since that time, the health physics,

medical, and biological programs of the Manhattan Engineer District and of the Atomic Energy Commission and its contractor-operators of plants, have kept ahead of operation problems. The record bears witness to the success of the precautions taken.

Although the dangers from radiation were unprecedented, and although tens of thousands of persons have worked in production and bomb plants during the last six years, very few have suffered from radiation injury. In May, 1946, nine persons were exposed in an accident during an experiment on bomb physics. One of these died[2], two others suffered injuries; the remaining six have apparently escaped unhurt. Several months previously, a similar accident had killed one man. Since May, 1946, five persons have suffered injuries, all of them local and much less serious than whole-body radiation. Four of these injuries occurred at one time during the Eniwetok bomb test, May, 1948. The fifth case occurred during special experiments at Los Alamos, and the man has recovered.

An Advisory Board on Safety and Industrial Health, a group of twelve distinguished authorities, appointed by the Commission to survey practices in these fields, reported in 1948: "History affords no parallel to the thorough study of, and protection against, radiation hazards to workers, from inception of the project to the present."

Safety Standards

IN ESTABLISHING its safeguards, the Commission has, whenever possible, adopted and used the standards established by the National Committee on Radiation Protection. The Committee includes representatives from the National Bureau of Standards, the Public Health Service, the Atomic Energy Commission, and from professional groups of radiologists and X-ray workers. Its members are the leading people in these fields.

One of the important standards set by this group established their estimate of the amount of whole-body radiation which a man could tolerate day after day without damage to himself. They knew that a patient who submits to an ordinary chest X-ray received about 2 roentgens during the short time the photograph required; that persons who submit to a complete gastro-intestinal series of X-ray pictures may receive as much as 50 to 75 roentgens to the abdomen.

Studying these records, and those of X-ray technicians, the Committee fixed the *daily permissible dose* of gamma and X-rays for a man at one-tenth of one roentgen, although actually it was estimated a man could stand at least ten times that much. Thus, the standard permissible dose allowed a safety factor of 10. More recently, experts have made a re-estimate and now believe that the safety factor is considerably less than 10—and consequently have recommended that the permissible dose of gamma and X-rays be cut in half-to five hundredths of a roentgen a day, or about three-tenths roentgen a week.

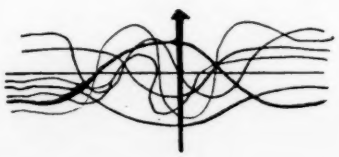
The diligence with which this standard of maximum permissible exposure is maintained is remarkable. For example, at the Hanford works where the potential radiation hazard is the greatest, the ten most exposed workers each received a total of *2 roentgens during the entire year*—about the amount of a single chest X-ray. If these men had received the maximum permissible radiation, the dose would have been 15 roentgens per year.

Protection of the Environment

FROM the beginning, the national atomic energy industry laid down the principle that its laboratories and plants must so control radiation and radioactive materials that there was no risk of causing injury to people who lived nearby, or to domestic or wild animals in the vicinity.

The chief sources of hazard to the environment are the air and water used to cool the nuclear reactors and industrial wastes. Control of air contamination has been so successful at Oak Ridge that the radioactivity of the air is less than 10 per cent greater than its natural radioactivity before atomic bombs were manufactured.

The same efficient management has been applied to liquid wastes that require disposal. The most serious potential source of radioactive contamination is the Clinch River serving Oak Ridge. The processes applied to the wastes are such that its activity is equal to 4 atoms disintegrating per spoonful of water per second. This is considerably lower than the harmless radioactivity of many popular mineral waters that are drunk in the United States.



Health Physics

THE success of the program for protection against radiation is due to the development of a new scientific discipline, designated "Health Physics." This discipline was initiated in the Manhattan Project and has been expanded and refined by the Atomic Energy Commission. The program depends heavily upon all workers in biology and medicine, but the chief responsibility for designing, carrying out, and enforcing safety measures rests upon some five hundred health physicists. Of these ten are broadly trained, and the rest are experienced in guarding personnel against radiation and in detecting radiation hazards. Large atomic energy projects employ most of these specialists, and there is a critical need for more, particularly of the broadly trained senior experts. As more and more universities, hospitals, and industries use radioisotopes, the need for trained health physicists will increase enormously.

The types of protection which the health physicists have developed and which they maintain are as follows:

Remote control techniques.—Amazingly ingenious devices have been invented which permit complicated laboratory procedures and entire industrial operations to be controlled by workers at a safe distance.

Personnel monitoring.—A series of devices are now in constant use, which permit the health physicist to record accurately the total exposure to radiation which each worker sustains. These devices include pocket ionization chambers, film badges, and film ring meters. No operation involving radioactive materials is undertaken in well-controlled laboratories unless the workers are equipped with some or all of these protective devices.

Analysis of body uptake.—Where workers are exposed to the hazard of ingestion, inhalation, or absorption of harmful amounts of radioactive materials, the Health Physics section conducts routine analyses of blood, expired air, and urine. Delicate techniques have been developed such that less than *one-billionth of a gram* of plutonium, for example, can be detected accurately.

Area monitoring.—Using sensitive monitors, health physicists routinely inspect all areas where radioactive material is

2 See *Bulletin*, I (June 1, 1946), 16.

used. Hazardous regions are decontaminated, eliminated, or marked off. A curious result of research in the solution of these problems is the discovery that certain insects concentrate some radioisotopes to a great extent in their bodies. Thus, at Brookhaven it was found that hornets could be used to detect leaks of radiobarium long before electrical devices could.

Instrument research. — Constant research is in progress to develop more accurate and more reliable instruments for use in the health protection program. Obviously, these same instruments, and the personnel trained to operate them, are available at all times for emergencies of any sort.

BENEFITS FROM ATOMIC ENERGY

ATOMIC energy's great gift to the sciences of biology and medicine is quantities of low-priced radioactive isotopes of the common elements that are important in the life processes of plants, animals, and men. All radioisotopes throw off rays or particles—Carbon 14 and Phosphorus 32, for example, emit beta particles; Iodine 131 and Sodium 24 radiate both beta particles and gamma rays—and it is these emissions which give them their special value to science.

In laboratory research radioisotopes are proving of great value. As "tracers," they are helping scientists to understand life processes and mechanisms which have been only partly understood for lack of such a key to unlock their secrets. Radioactive carbon, for example, enters into life processes almost exactly like stable, or natural, carbon. By means of counters or photographic film to record carbon's emission of beta particles, scientists can trace the movement of the element through living tissues and through complex chemical reactions.

In clinical research, techniques are being devised to employ radioisotopes in diagnostic tests; and in experiments designed to elucidate the peculiar functioning of the human organism in health and disease. The potential hazards to people from this use of isotopes is well recognized, and exceptional care is taken by all concerned to reduce this hazard to the greatest extent possible. Some of the radioisotopes are now being used in treatment of cancer and allied diseases.

Most of the progress in the application of isotopes to research in biology and medicine is due to the Isotope Program of the Atomic Energy Commission. The distribution of isotopes produced in the giant nuclear reactors at Oak Ridge was initiated in the Manhattan District, and it has been greatly increased by the Commission. The figures for shipment of pile-produced radioisotopes are as follows:

August '46-June '49
Shipments 6,359
Number of Institutions...309

The most active utilization of radioisotopes has been in the field of *Tracer Research.* At the present time nearly every chemical reaction occuring in animals is being re-investigated using labelled chemicals. The key reactions of living organisms which supply the energy necessary for life are being studied in a number of laboratories with a thoroughness which leaves little room for doubting that eventually these processes will be understood. In addition to the study of normal phenomena, the perverted reactions that occur in diseased states are being studied in a similar manner.

The application of radioisotopes to diagnostic tests has been most fruitful in the case of thyroid disease, where the use of radioiodine has been developed to a remarkable extent. It is now generally accepted that complete study of a patient with thyroid disease includes a radioiodine test. The neurosurgeons have learned to use both radioiodine and radiophosphorus to aid them in locating and treating brain tumors. Other techniques are under investigation to aid in solving problems of heart disease, circulatory disease, and the like.

In the treatment of non-cancerous conditions radioisotopes have found a limited use to date. The ability of radioiodine to control abnormal thyroid function is the most important application of this sort; but other uses are being studied, and should ultimately be found.

Radiation is one of the best established forms of treatment of cancer. It has been quite logical to study methods utilizing radioisotopes for this purpose. The AEC is expanding its part in the quest for knowledge about cancer and for means of controlling it. Recently the Commission has taken the following steps:

a) Approved plans for the 50-bed Argonne Cancer Research Hospital and for a 32-bed clinical cancer research hospital at Oak Ridge.

b) Supplied all radioisotopes now being sold to qualified cancer research workers in the United States without production charges.

c) Sponsored research, and provided radioisotopes, to determine the efficiency of radiocobalt (Cobalt 60) as a substitute for radium in the treatment of cancer.

The forms of cancer that are now being routinely treated by the use of radioisotopes are as follows:

Thyroid cancer.....radioiodine
Leukemia and allied
diseases .....radiophosphorus
Polycythemia ....radiophosphorus
Infiltration treatment of
various cancers .....radiogold
Local treatment of various cancers
....radiocobalt, radiophosphorus

In addition to these agents, a large number of experimental studies are in progress using nearly every radioisotope whose physical properties (half-life, energy) make it suitable for human use. A great deal of effort and ingenuity is being devoted to these studies, and evaluation of them at this time is impossible.

Radiation and Agriculture

PARALLEL to efforts to use radiation and radioisotopes for the direct medical benefit of mankind, the atomic energy program is aiding in research which adds to basic knowledge of the effects of radiation on food-producing plants and animals. Typical among projects sponsored by the Commission are: *(a)* a study at University of Tennessee of the effects of radiation upon cattle exposed to radioactive dust outfall from the Alamogordo (N. Mex.) bomb test; *(b)* widespread studies managed by the Department of Agriculture on the effects of radioactive fertilizer on growth of plants; *(c)* studies by the Department of Agriculture directed toward understanding how fertilizers feed into plants and determining the most favorable cycles of fertilizer application; and *(d)* an extensive group of projects dealing with such diverse subjects as studies on photosynthesis of plants; mineral nutrition of plants and domestic animals; use of radioactive materials as tracers to study action of fungicides and herbicides; the action of radioactive materials on disease-producing fungi; and the possibilities of using radioisotopes for therapy in plant diseases.

The Program in Research of the Division of Biology and Medicine is conducted in two categories: first, in the laboratories operated by the AEC, and second, under contract. At the present time unclassified biological and medical research is being carried out in more than sixty universities, hospitals, and institutions in all parts of the United States. Training is an insep-

(Continued on Page 322)

UNITED NATIONS ATOMIC ENERGY NEWS

Francis W. Carpenter

PRESIDENT Truman's announcement that there had been an atomic explosion in the Soviet Union gave the question of international control of atomic energy an urgent priority in the Fourth United Nations Assembly.

Secretary of State Dean G. Acheson held a press conference in the Assembly building at Flushing Meadows on September 23, 1949, shortly after President Truman issued his announcement in Washington.

To a room full of newsmen, Acheson said he had known about the Soviet atomic development when he made his policy speech to the U.N. Assembly September 21. He did not mention it then. He said the U.S. had been aware of increasing evidence on that score for some time.

Acheson repeated again and again the idea that the development had been expected and that the United States would go about its business as usual.

The Secretary of State said that he wanted to bring home to the newsmen that this is not something totally unexpected and unknown. He said it might be a considerable shock to people who had not thought about the situation but that, if anyone in the world had been told, our people had been told that the development was coming. When it happens, he added, there is no reason to believe things in the world have to be changed. He said we would proceed to go about our business in an orderly way.

Later the State Department issued the following extract from Acheson's press conference for direct quotation:

"I want to emphasize the four basic matters which were brought out in the President's release this morning. Those are: the President has stated the fact that there has been an atomic explosion in the Soviet Union. In the second place, the President has stated that we have been fully aware that sooner or later this development would occur and that in our thinking it has been taken into account. That is an important fact to remember. In the third place, the President has recalled what so many people have forgotten, that in every statement made by him and by the two Prime Ministers as well as by all the commissions and bodies which have studied this matter, it has always been clearly pointed out that this situation would develop. And finally, the President has stated that this event makes no change in our policy.

"This nation, from the very beginning of the development of atomic power, has been determined to do everything in its power to proceed toward a truly effective international control of atomic energy. It would be deluding ourselves to get something on paper that is not really effective. The President's statement underlines the importance of having an effective method of control.

"We are continuing our most earnest efforts in the organization of the world toward peace. That, of course, is the whole purpose and reason for the great efforts which we have made here in the United Nations, in the Rio Treaty, in the North Atlantic Treaty, in the military assistance bill and in the Marshall Plan. The entire foreign policy of this government is directed toward the organization and preservation of peace. It is only through the success of those efforts that we wil lavoid the increased hardships and perils of war."

THE U.N. ASSEMBLY

When the Assembly convened in New York City September 20, the general feeling among the delegates was that they would not hear much about the atom at this meeting. But Mr. Truman's disclosure split the atomic issue wide open once more in the Assembly, and anything can happen now.

The declarations of Secretary Acheson and the Foreign Ministers of the United Kingdom, France and the Soviet Union to the General Assembly sum up in general the positions of those four powers on atomic control. They also are a good index to the thinking of those four governments on the present impasse. Acheson was the first representative of the big powers to make a policy statement to the plenary session of the Assembly. On the atomic issue he said:

"My Government deeply regrets that no agreement has been reached in the United Nations on the international control of atomic energy and the prohibition of atomic weapons.

"The United States is continuing and will continue to strive for an effective system of international control of atomic energy which would make effective the prohibition of atomic weapons. That is why we support the Commission plan of control and prohibition as approved by this General Assembly last year. It is clear from the resolutions passed by the General Assembly on this subject that the overwhelming majority of the members of the United Nations also support effective control and effective prohibition.

"Because the Soviet Union refused either to accept this United Nations plan or put forth any other *effective* plan of control and prohibition, the United Nations Atomic Energy Commission has reported again the impasse confronting it. The Commission found that its discussions were not enlarging areas of agreement. On the contrary, they were hardening existing differences. Therefore, it concluded that there was nothing practicable or useful it could do until the Sponsoring Powers had reported that a basis for agreement existed.

"As one of the six powers that sponsored establishment of the United Nations Atomic Energy Commission, we are endeavoring, in response to the request of the last General Assembly, through consultation among the Sponsoring Powers, to find such a basis for agreement. In our view, that offers the best prospects of determining whether any hope remains for finding such a basis. We stand ready to discuss any proposal advanced in good faith for effective international control of atomic energy and for effective prohibition. But we must state in all candor that unless and until the Soviet Union demonstrates a willingness to cooperate in the world community and, in the field of atomic energy, gives evidence of such a willingness by agreeing to a truly effective, enforceable system of international control and prohibition, there is no hope that a basis for agreement can be found."

Foreign Minister Robert Schuman, of France, touched briefly on the issue in

his speech to the Assembly September 23, just a short while before Vishinsky spoke.

He said the problem of atomic control remains in an "impasse" and is liable to remain there for a long time "unless there is a radical change in peoples' minds and international relations."

Vishinsky gave the atomic problem slightly more space. He did not refer to the President's announcement nor did he hint even that Russia has an atomic bomb.

Instead, he attacked the Western position on atomic control again and once more demanded immediate prohibition of the bomb. In his speech to the Assembly he said:

"Notwithstanding the fact that the war has long ended, the United States of America, far from liquidating the hundreds of military bases it had built in all parts of the world during the war, is continuing to build ever-new military, naval and air bases. The United States of America and the United Kingdom have created joint military staffs consisting of the representatives of the states—members of aggressive blocs which are now busily drawing up plans for a new war, assigning a prominent part in those plans to atomic weapons, on which the warmongers are pinning their main hopes. Is it surprising that, this being the position, the United States of America and the United Kingdom are refusing to conclude conventions for the prohibition of atomic weapons, preferring to do without such conventions in order to have a free hand? It will be recalled that civilized nations had long ago condemned the use of poison gases in wartime for the mass annihilation of human beings and had renounced the use of such a weapon. As far as atomic weapons are concerned, however, the governments of the United States of America and the United Kingdom do not agree to follow this path and to renounce the use of this weapon of aggression intended for the mass annihilation of people."

He introduced a resolution for a Big Five Peace Pact in which he also wrapped up the ban on atomic weapons.

THE SOVIET RESOLUTION

The text of the Soviet Resolution dated 24 Sept. 1949, (A/996) follows:

"On the instructions of the Government of the Union of Soviet Socialist Republics, the USSR Delegation submits the following resolution for the approval of the General Assembly:

"1. The General Assembly condemns the preparations for a new war now being conducted in a number of countries, and particularly in the United States of America and the United Kingdam, as reflected in the war propaganda encouraged by Governments, in the armaments race and the inflation of military budgets inflicting heavy burdens on the people, the establishment of numerous military, naval and air bases on the territories of other countries, the organization of military blocs of states pursuing aggressive aims directed against peace-loving democratic countries, and the implementation of other measures having aggressive purposes.

"2. Just as the civilized nations long since condemned as a heinous crime against humanity the use for military purposes of poisonous gases and bacteriological media, the General Assembly regards the use of atomic weapons and other means of mass destruction as being contrary to the conscience and honor of the nations and incompatible with membership of the United Nations, and considers as inadmissible any further delay in the adoption by the United Nations of practical measures for the unconditional prohibition of atomic weapons and the establishment of appropriate strict international control.

"3. The General Assembly calls upon all States to settle their disputes and differences by peaceful methods, and to refrain from resort to force or the threat of force. The General Assembly, taking note, in this connection, of the undeviating desire and will of the peoples to avert the threat of a new war and ensure the maintenance of peace—as expressed in the mighty popular movement in all countries for peace and against the warmongers—and having regard to the fact that the primary responsibility for the maintenance of international peace and security lies on the shoulders of the five powers, permanent members of the Security Council, unanimously expresses the wish that the United States of America, the United Kingdom, China, France, and the Union of Soviet Socialist Republics will unite their efforts to this end and will conclude among themselves a Pact for the Strengthening of Peace."

The Steering Committee of the Assembly recommended that the item go on the agenda, and it was sent by the full Assembly to the Special *ad hoc* Political Committee set up to take some of the load off the regular 59-nation Political Committee.

The subject is not expected to come up until the Sponsoring Powers turn in a report on their secret talks. This will be the signal for new blasts on the atomic problem in the U.N.

Ernest Bevin, Foreign Secretary of the United Kingdom, dealt with Vishinsky's speech in his address to the Assembly on September 26, 1949. The section on atomic energy and on Vishinsky's resolution follows:

"The Assembly will expect me to deal, however shortly, with the question of atomic energy. Mr. Vishinsky has repeated the threadbare accusation that the Atomic Energy Commission had failed to fulfill the task given to it by the General Assembly, because of continuous attempts on the part of the United States and the United Kingdom to impose on the Commission a plan which was unacceptable to self-respecting nations. What are the facts with regard to this so-called imposed and unacceptable plan? So far from being imposed, the plan resulted from several *years work in the Commission — in which, let it be remembered, 19 members of the United Nations have taken part at various times.* All the members of the Commission but two accepted it in preference to the Soviet Union's plan, put forward in June, 1947. Both plans had been thoroughly examined and exhaustively discussed. And the Commission's acceptance of the plan was endorsed in November last by no less than 40 members of the General Assembly. Are they flattered by the suggestion that they were coerced into adopting a plan which no self-respecting nation could accept?

"The Soviet representatives never cease to harp on prohibition of the atomic weapon and to blame us and others for failing to make prohibition a reality. This is a stupid charge. We are as anxious as anyone for prohibition. The original declaration by President Truman, Mr. Attlee, and Mr. McKenzie King, issued in Washington on November, 1945, called for the elimination of the atomic weapon.

"The resolution of the General Assembly of January 24, 1946, repeated this call.

"Since then a series of resolutions adopted by overwhelming majorities in the Atomic Energy Commission itself have emphasized this essential aim of the elimination of the atomic weapon. But we and others have recognized that effective prohibition depends on effective control of atomic energy. In common with others we support the plan approved by the General Assembly because it would provide for effective control which the Soviet plan would not. Nevertheless, the Soviet Government have clung obstinately to the proposals for control which they put forward in 1947 and which have been rejected over and over again as inadequate. They have continued to decry the plan ap-

proved by the Assembly. Are we to understand that the Soviet delegate will now accept the decision of the United Nations?

"It is not obstruction on our part or on the part of those who think as we do that has prevented agreement over the past years. The fault lies with the Soviet Union, who have refused to consider any plan but one based on their own inadequate proposals. The Soviet representative called on the 23rd September for the 'unconditional prohibition of atomic weapons and for the establishment of an adequate and rigid international control.' President Truman's statement on the same day reemphasized the need for 'truly effective and enforceable international control.' The Russians have consistently put forward 'independence and sovereignty' as reason for avoiding the effective international control provided in the General Assembly's plan. *If they had been willing to come out of their shell, to raise their curtain, and to open the way to the system of control approved by the General Assembly—which we and others believe to be the only workable and effective system yet devised — there might well have been effective prohibition today.*

"We adhere to the original declaration of President Truman, Mr. Attlee, and Mr. McKenzie King issued in Washington in November, 1945, and we are *ready to take all constructive steps to give effect to it.*

"Mr. Vishinsky constantly asserts that a Convention prohibiting the use of an atomic weapon would in itself be enough, and in support of his argument he finds analogy in the Convention relating to Gas Warfare.

"It has been assumed that the Gas Warfare Convention prevented the use of gas during the last war. I very much doubt it. I understand that under the Gas Warfare Convention no provision existed for enforeable inspection. Enforcible inspection was certainly never applied, and it became known to us that the Germans were producing gas, and it was feared that they would use it. Generalissimo Stalin had received the information and requested my Government to issue an announcement that should Germany resort to the use of gas, we would retaliate to our fullest extent. This announcement was made and the production of gas was speeded up in order that we could effectively carry out our intention to retaliate should Germany resort to gas warfare. This situation arose because there was no provision in the Convention for inspection. The absence of such a provision constitutes a grave risk when dealing with inhuman weapons. Our own approach has always been collective security, disarmament with inspection, and enforceable control."

SIX POWER TALKS

Spurred by President Truman's announcement, newsmen at the U.N. Assembly asked both Secretary Acheson and the U.N. itself to lead the way for open meetings of the Sponsoring Powers.[1]

Acheson answered that the request would be taken into consideration. But newsmen recalled that at his press conference, when asked if the United States would take the lead toward open discussions, Acheson had made it plain such open meetings were the last thing the U.S. wants at this time. He indicated clearly that the U.S. Government believes the countries should have a chance to exchange ideas without benefit of publicity—and that the U.S. certainly would not take the lead in trying to open the secret talks.

When the first meeting of the six countries after Mr. Truman's announcement was held 29 September, 1949, the following communique was issued:

"The representatives of the permanent members of the Atomic Energy Commission—Canada, China, France, Union of Soviet Socialist Republics, United Kingdom, United States—held their eighth meeting on Thursday 29 September. They are consulting together, pursuant to Paragraph 3 of the General Assembly resolution of 4 November, 1948, 'in order to determine if there exists a basis for agreement on the international control of atomic energy to ensure its use only for peaceful purposes, and for the elimination from national armaments of atomic weapons.'

"In accordance with the direction of the General Assembly, a report on these consultations will be submitted during the present session of the General Assembly, and provision for consideration of this report has been included on the General Assembly's agenda.

"The basis for these consultations is a frank review of the whole situation. To this end the representatives need to have the opportunity to state their views with complete freedom in relation to the various matters as they come under discussion. For this reason it has been concluded that the effective conduct of these conversations requires the continuance, for the time being, of the present practice of closed meetings. This practice has been adopted so that representatives may have freedom not only to state views, but to develop any suggestions which may be indicated through this new method, in order that every possible avenue may be explored which might lead towards the fulfillment of the General Assembly's instructions to determine whether a basis of agreement can be found."

Warren R. Austin, United States permanent delegate to the U.N., told a meeting of the American Association for the United Nations that night that it had been a "good meeting" and this was as far as anyone has gone even to disclose the atmosphere of the talks.

[1] The talks of the six countries were requested by the U.N. Atomic Energy Commission in its resolution of July 29, 1949. They began in August.

AEC Sixth Report

(Continued from Page 319)

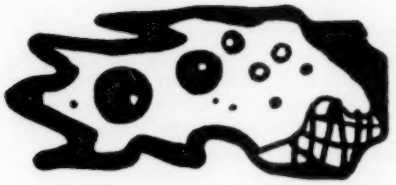
arable part of scientific research. A very large number of advanced students in biology and medicine receive training in connection with the more than one hundred contracts of AEC. The national laboratories and other research establishments of the Commission, with their scores of associated universities, also are being developed as centers of training as well as research. The Oak Ridge Institute of Nuclear Studies, associated with the Oak Ridge National Laboratory, and operated by twenty-four universities of the South under contract with the Commission, offers a variety of training opportunities, including a series of extremely popular courses in radioisotope utilization.

The fellowship program provides for 350 annual awards in the field of biology and medicine; 100 postdoctorals in medicine; 50 postdoctorals in biology; 175 predoctorals in biology and health physics; and 25 technical fellowships in health physics. Up to the present time, over 200 awards have been made.

During the past year, the Commission has expanded its previously existing activities at the various universities and colleges which are developing training programs in this field. These institutions were originally selected for their scientific competence and the opportunity to combine medical, biological, physical, and mathematical programs, and their geographical location. During the past year all have offered courses for physicians including ten representatives from the Armed Forces who were trained in the sciences which are basic to an understanding of atomic energy.

TO THIS reviewer, the report of the Division of Biology and Medicine of the AEC is a comforting document. It is good to learn that the great intellectual adventure which made atomic energy available to man is being devoted to a worthier purpose than the destruction of Japanese cities.

MORE SCIENTISTS COMMENT ON SOVIET BOMB



LINUS PAULING

President, American Chemical Society

THE statement by President Truman that an atomic explosion has occurred in the USSR has not come as a surprise to the scientists of the United States. Four years ago it was estimated by the men who worked on the atomic bomb project that the Russian scientists and engineers would be able to build an atomic bomb in approximately five years, by making use of information available to every nation, as summarized in the Smyth Report. So far as I am aware, the Smyth Report did not contain any information in the field of pure science that had not already been published, and it is my opinion that the technical processes referred to in the Smyth Report as having been used successfully for the production of fissionable material would surely have been tried out by the Russians whether or not they were mentioned in the report.

Since this development, the occurrence of an atomic explosion in Russia, is one that we have been expecting; there is no reason for the people of the United States to be unduly excited by it. I believe that the event should, however, serve to point out the necessity of taking immediate action to avert the atomic catastrophe that the world is facing. I believe that it should be a warning to the people of the world and a potent incentive to the nations of the world to resume negotiations, through the United Nations Organization for the establishment of an effective system of international control of atomic energy. These negotiations, to be successful, will have to be carried out in a spirit of compromise and mutual cooperation between the East and the West.

This is, of course, a very difficult task. An effective system of control of atomic energy would require the relinquishment of a certain amount of national sovereignty, and this has been opposed in the past both by Russia and by the Western nations. The supernational organization controlling atomic energy would have to be provided with teeth, and both the East and the West would have to agree to the transfer of power to this organization in the interests of the world as a whole. In answer to the question as to how the United States has obtained the information that an atomic explosion has occurred in Russia, I would say, not as an atomic scientist, but from a general background of knowledge of physics and chemistry, that it probably has been obtained by the measurement, with Geiger counters, of an increased amount of radioactive material (the products of fission) in the air, the time required for these products of fission to be distributed over the earth's surface by the motion of air masses being approximately a week. The amount of radioactivity distributed over the earth's surface this way is not great enough to be dangerous to man.

SIR JOHN BOYD ORR

Former Director General of the FAO

THE fact that both sides are armed with new weapons invented in the last few years will help prevent war.

Those in power know that a war with atomic bombs and biological weapons would cause widespread death and destruction followed by political convulsions from which few of them would remain in power or even alive.

No government will willingly declare war. The danger is that in the present cold war, the armament race and propaganda stirring up fear and hatred will create an inflammatory political atmosphere in which some otherwise trifling incident will flare into a world war.

The road to peace lies through cooperation of governments and concrete measures of benefit to all. Political conflict, either national or international, is largely an appeal to emotion.

In business, people get down to concrete realities and reach agreement on the basis of the facts instead of interminable debates on ill-defined political abstractions.

Let the great powers begin to consider how they can cooperate to fulfill the promise of the Atlantic Charter —freedom of work for men of all lands.

If the powers of modern science were applied to this end, we would be well on the road to peace. Social unrest among the hungry and poverty-stricken people of the world would be allayed. Economic difficulties would be solved. There would be a world market for all that agriculture and industry could produce.

This would bring about a world of plenty for agriculture, industry, and trade, with full employment and rapid rise in the standard of living of the people of all countries.

The Food and Agricultural Organization and Economic Council, the World Bank and other agencies of the United Nations were set up for this purpose. Let the governments begin to make these do the job for which they were created.

It was to this end that in 1946 when Director General of the FAO (Food and Agricultural Organization) I submitted proposals for a world food board through which all nations would cooperate to double world food production in the next twenty-five years, with stabilized prices in the international food markets at levels fair to producers and consumers.

The majority of governments were willing to cooperate. The United States approved and moved a motion to set up a commission to get it going, but one or two had no enthusiasm for it.

Both the political and the economic positions in the world have deteriorated since 1946 because some governments are more concerned with their immediate national interests than with the contribution they can make to world peace and prosperity upon which the fate of all nations depends.

Let governments begin to discuss business instead of politics. Let them consider joint action in plans like the world food plan, which nearly succeeded.

Some say Russia will not cooperate. If the great majority decide to cooperate in a world plan of development

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Sir John Boyd Orr's statement used by courtesy of United Press.

beginning with food, and to contribute each in proportion to its wealth and resources, it would be difficult for Russia to keep any of its allied nations out of the world food and prosperity pact. Let us not condemn Russia until another generous and friendly offer of cooperation has been made.

World unity and peace will come as soon as there is a well-informed, worldwide public opinion demanding the cooperation of all nations in building up the new and better world of the Four Freedoms.

Let people of all nations get together through international organizations such as Federal Union, the Crusade for World Government, the Peace Union, the Women's League for Peace and Freedom; and let them invite delegates from all countries, including Russia, so that the voice of the people of the world can be heard strengthening every movemnt for world unity, giving all peace-loving governments the courage needed to take the lead in the march of mankind to a future of world unity, prosperity, and peace, which are the only alternatives to a war in which our civilization would commit suicide.

ENRICO FERMI

Distinguished Service Professor
University of Chicago

"If the United States maintains atomic supremacy over Russia there will be no war for 20 years.

"American supremacy is predictable up to 20 years if we work hard. As for me, I expect to sleep as well as my insomnia permits. I'm a fatalist by nature, anyway."

U S Strategic Bombing Survey Appraises Use of Atomic Bomb

The question whether the atomic bombing of Hiroshima and Nagasaki was decisive in causing Japan to surrender without invasion of her home islands and consequent enormous losses on both sides, has played an important role in the discussion of the political and military wisdom of the decision to use the bomb.[1]

We reprint here, as a contribution to this controversy, the concluding statement from the pamphlet, *Japan's Struggle to End the War*, prepared by the U. S. Strategic Bombing Survey. The pamphlet was published in 1946, but, like the other volumes of the Survey, aroused little public interest. (Not so long ago, Professor Blackett forcefully drew attention to this fact, by the extensive use of the Survey material in his book, *Fear, War, and the Bomb.)*

The Survey's conclusion, that the surrender of Japan without actual invasion was assured by the effects of blockade and aerial bombing, even without atomic bombing, might have been influenced by the strategic concepts of the Navy or the Air Force. Nevertheless, this conclusion, based on extensive studies and interrogations of Japanese leaders, is one of the most authoritative statements on the subject to date:

"There is little point in attempting to impute Japan's unconditional surrender to any one of the numerous causes which jointly and cumulatively were responsible for Japan's disaster. Concerning the absoluteness of her defeat there can be no doubt. The time lapse between military impotence and political acceptance of the inevitable might have been shorter had the political structure of Japan permitted a more rapid and decisive determination of national policies. It seems clear, however, that air supremacy and its later exploitation over Japan proper was the major factor which determined the timing of Japan's surrender and obviated any need for invasion.

"Based on a detailed investigation of all the facts and supported by the testimony of the surviving Japanese leaders involved, it is the Survey's opinion that certainly prior to December 31, 1945, and in all probability prior to November 1, 1945, Japan would have surrendered even if the atomic bombs had not been dropped, even if Russia had not entered the war, and even if no invasion had been planned or contemplated."

1 See "A Report to the Secretary of War. . . . June, 1945," *Bulletin*, I (May 1, 1946), 2-4, 6; also see Henry L. Stimson, "The Decision to Use the Atomic Bomb," *Bulletin*, III (February 1947), 37-41, 66.

Major Expansion Planned For U.S. Atomic Plants

On October 18, President Truman authorized the Atomic Energy Commission to dip into its budgetary reserve for funds to begin a major expansion of its production program. The initial approved withdrawal from the reserve, now just under $70,000,000, is $30,000,000 and will be used for construction at the Oak Ridge and Hanford plants. This authorization, according to Senator McMahon, will step up the nation's over-all atomic energy construction by several months.

In a related move, Congress, at the close of the session, rushed through legislation to relax the curb it had previously placed on the Commission's spending powers.

In July of this year Congress attached a rider to the AEC appropriation bill forbidding the Commission to start new construction projects not provided for in the budget for the current year, or which exceed the estimates contained in that budget, unless specifically approved by the Bureau of the Budget and reported to the Appropriations Committee of both Houses and to the Joint Committee on Atomic Energy. Under the new amendment the Commission can start construction of unbudgeted technical or production facilities if it satisfies the budget director that they are necessary for the national defense.

AEC Signs Contract With Western Electric for Operation of Sandia

THE U.S. Atomic Energy Commission has signed a contract with the Western Electric Company, a subsidiary of the American Telephone and Telegraph Company, for the operation of the laboratory at Sandia Base.

The Laboratory has been operated by the University of California since 1945 under the University's contract for the operation of the Los Alamos Scientific Laboratory. Several months ago the University expressed a desire to be relieved of its responsibilities at Sandia, and the Western Electric Company was selected as its successor.

The Western Electric Company will operate the Laboratory through a new, wholly-owned subsidiary named the Sandia Corporation. This corporation will call upon both the Western Electric Company and the Bell Telephone Laboratories for scientific services and technical and managerial assistance.